JUL 19 1918

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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See page 101. 6455

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See Full Page Advt., page 58, May 31.

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Walter Somers & Co., Ltd.,
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See Advertisement page 46, June 7. 3403

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See Full Page Advertisement May 31.

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See half-page Advertisement page 86, June 14.

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The Plant may be inspected by appointment, and tender forms and conditions of sale obtained upon application to the Chief Engineer and Manager, Electricity Works, Lithos Road, Finchley Road, N.W. 3. Tenders, endorsed "Tender for Steam Plant," to be delivered at my office, not later than Monday, 1st July next.

By order.
ARTHUR P. JOHNSON,
Town Clerk.

Town Hall,
Haverstock Hill, N.W.
June, 1918. L 829

APPOINTMENTS OPEN.

DARLINGTON COUNTY BOROUGH.

TECHNICAL COLLEGE.

Principal of Technical COLLEGE WANTED. Commencing salary £450 per annum. Candidate must be a Graduate of a British University, with special qualifications in Physical and Engineering Sciences and must have had practical experience in Engineering work.—Forms of application may be obtained from the undersigned, and must be returned not later than July 6th, 1918.

A. C. BOYDE, Secretary.
Education Office, Darlington,
June, 1918. L 749

Laboratory Assistant required by Controlled Electrical Engineering Firm in Midlands; University degree or equivalent, and experience in Magneto investigation and testing desirable. No person already on Government work will be engaged.—Apply, stating age, qualifications and salary required, through your nearest EMPLOYMENT EXCHANGE, quoting No. A 5501. L 787

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Applications are Invited for the POST of TEACHER of ENGINEERING, duties to commence in September next. Commencing salary £250.
Forms of Application, which must be returned not later than July 5th, may be obtained from R. DEMPSEY, Clerk to the Governors, 1, Selborne Road, Walthamstow. L 875

Superintendent Engineer for large industrial works within 20 miles of London. Plant to be looked after is new and modern, embodying all latest improvements comprising conveying, crushing, hydraulic machinery, steam and electric power plant. Applicants having previous experience with plant running continuously 168 hours per week will receive special consideration. Expert chemists and allied technologists to operate specialised departments. Salary commensurate with experience and ability of applicant.—Applications, stating full particulars of training and other experience, to be sent to L 762, Offices of ENGINEERING.

Supervising Engineer REQUIRED for shore work, knowledge of ammonia and CO_2 refrigerating machinery essential, marine training preferred. Good position for the right man.—Reply, with copies of references, to BOX 632, T. B. Browne's Advertising Offices, 168, Queen Victoria Street, E.C. 4. L 765

Cost Clerks.—Wanted im- mediately in a large controlled Factory in East Midlands, two or three experienced men for Estimating Dept. Must be thoroughly conversant with reading and taking off quantities from drawings, etc. No person already on Government work will be engaged.—Apply, stating full particulars of experience, salary required, etc., to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5540. L 869

Clerk for Engineering Depart- ment of Controlled factory in Scotland. Typist, preferably, with experience in modern costing systems. Ineligible. No person already on Government work will be engaged.—Applicants must apply to their nearest EMPLOYMENT EXCHANGE, mentioning this Journal and L 872.

Wanted for National Aircraft Factory, PRACTICAL MEN for Rate fixing and Processing department. Drawing office experience desirable but not essential. No person already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, quoting No. A 5555. L 866

Rate Fixer.—First-class Tool- room Rate Fixer REQUIRED, by a firm in the Midlands engaged on Aero Engine production. Applicants must have had a tool room experience of high-class work. No person already engaged on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5503. L 803

Engineer Wanted in London, experience in complete oilfield machinery essential. Able to prepare specifications. Must be prepared to travel abroad if necessary.—Write, fully, giving age, experience and when disengaged, A.Z., care of Messrs. Ellis & Co., Solicitors, 30, John Street, Bedford Row, W.C. 1. L 820

Assistant Engineer. A Large organisation in the Midlands requires the services of an up-to-date ENGINEER. Man experienced in the design and lay-out of heavy chemical plant preferred. Please state details of qualifications and experience, and the salary expected No one already on Government work will be engaged. —Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and L 837.

First Assistant in Purchasing DEPT., REQUIRED by a Controlled firm in the neighbourhood of Bristol manufacturing Aero Engines. Only men who have had experience in a similar position and not already on Government work should apply, stating age, experience and salary required, also position as regards Military service, to nearest EMPLOYMENT EXCHANGE, mentioning ENGINEERING and L 840.

Commercial Assistant Wanted, for sale of material to Steelworks, Iron Founders, Builders, Contractors; one with little chemical or furnace knowledge preferred. Energetic man of good education. Discharged or ineligible for Army.—Address, giving previous experience, with references and salary required, L 839, Offices of ENGINEERING.

Required, for London Aero- plane factory, N.W. district, DRAUGHTSMAN to assist in checking of Tool Drawings. Must be accurate and reliable. No one living more than 10 miles away or at present engaged on Government work need write to BOX 537, SELLS, Ltd., 168, Fleet Street, E.C. 4. L 856

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DEPARTMENT OF ELECTRICAL ENGINEERING.

Electrical Draughtsman REQUIRED with experience either in machine and control gear design or general ship electrical installations.—Apply, giving details of experience, stating age, salary required, and forwarding copies of recent testimonials to DIRECTOR OF ELECTRICAL ENGINEERING, Admiralty, Great George Street, London, S.W. 1. L 857

Required, Engineer and DRAUGHTSMAN, used to Factory Construction and Equipment. Good knowledge of steelwork and reinforced concrete preferred. Salary about £300.—Write, BOX 73, at HORNCASTLE'S, 60, Cheapside, E.C. 2. No one on Government work or residing more than 10 miles away need apply. L 830

Wanted, by Firm doing Government contracts, DRAUGHTSMAN with knowledge of Water Purification plant. No one already on Government work or resident more than 10 miles away need apply.—Address, stating full experience and salary required, L 815, Offices of ENGINEERING.

Wanted, Experienced and capable Jig and Tool DRAUGHTSMAN, preferably with experience of Motor Vehicle Manufacture. London district. No person already on Government work will be engaged.—Apply, stating age, salary and full particulars of experience, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 3929. L 803

Draughtsman, with Expe- rience of General Chemical Plant, WANTED. This is a good opportunity in a progressive group of factories. No one already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and L 838.

Temporary Civil Engineering DRAUGHTSMAN, with experience in Waterworks practice, REQUIRED in Corporation office. Ex-Service man preferred.—Full particulars of experience and salary required to BOX 276, JUDD'S, 97, Gresham Street, E.C. 2. L 674

Draughtsman Required for engineering shop in East London. Must have practical experience of jig and tool design. Permanency for suitable man. State full particulars and salary. No one already on Government work or resident more than 10 miles away need apply.—Address, L 868, Offices of ENGINEERING.

Draughtsman Wanted for Aircraft Work in London District, previous experience of aircraft not essential, but knowledge of Stresses desirable. No one at present on Government work or resident more than 10 miles away will be engaged.—Address, L 733, Offices of ENGINEERING.

Experienced Aero Engine DRAUGHTSMEN, of designing ability, REQUIRED by a North Midland Aero Factory. Good position and salaries to suitable applicants. No person already on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5465. L 730

A Large Aircraft Factory in N.W. London, manufacturing machines of their own design, REQUIRE a number of Detail DRAUGHTSMEN with first-class aeronautical experience. Exceptional opportunities and permanent positions offered to suitable men. No one at present engaged on Government work or resident more than 10 miles away need write to BOX 480, SELLS, Ltd., 168, Fleet Street, E.C. 4. L 665

Electrical Draughtsman REQUIRED immediately for diagram, layout, and record work, by controlled establishment with large H.T. and L.T. 3-phase A.C. system. Good wages and prospects for suitable man to qualify for permanent post as Assistant Engineer. No one already on Government work will be engaged.—Apply at your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5450. L 737

Draughtsman (Mechanical Engineer), WANTED, on Tyneside, accustomed to general industrial building construction and lay-out of machinery and plant. No person already on Government work will be engaged.—Apply, stating age, experience, and salary expected, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5474. L 728

Wanted, Marine Engine Pipe Arrangement DRAUGHTSMAN, must be thoroughly conversant with Boiler Room Installations for Destroyers and similar vessels. No one at present engaged on Government work need apply.—Reply, stating age, experience and wage required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and A 5456. L 702

Tool and Plant Draughtsmen REQUIRED for urgent aero and motor work in progressive Midland works. Permanencies for live interested quick men with initiative and ability. No person already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE mentioning No. A 5316. L 477

Draughtsman Required, with good experience in design of Steelworks Machinery preferred, although applications from high-class men with other experience would be considered. No one already on Government work will be engaged.—State age, experience and salary required and when at liberty, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4694 K 593

Leading Draughtsman Wanted Manchester District. Government Contracts. Thorough experience furnace work essential, experience structural work an advantage.—Address, stating age, experience, and salary required, L 378, Offices of ENGINEERING.

Good Mechanical Engineering DRAUGHTSMAN REQUIRED.—State age, experience, and salary required. No person already on Government work will be engaged.—Apply, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and L 834.

Draughtsman Required Im- mediately, thoroughly experienced in Semi-Diesel Oil Engines, land and marine. Good salary will be paid to suitable man. No person already on Government work will be engaged.—Apply, stating age, experience, and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 5300. L 808

Draughtsmen.—Two or Three Draughtsmen WANTED, accustomed to iron and steel works practice, for construction of New Steelworks, East Coast. No person already engaged on Government work will be employed.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5492. L 810

Draughtsmen, Mechanical.— Several first class Draughtsmen REQUIRED, for the Design Dept. of a large Aircraft establishment in West of England. Applicants preferred with practical experience, not necessarily on aircraft.—Application to be made to your nearest EMPLOYMENT EXCHANGE, stating salary required and mentioning No. A 5534. No person already on Government work need apply. L 811

Draughtsmen Required in City Office. Ex-service men with good all-round experience will be given preference. Good wages paid to capable men. No one employed on Government work or resident more than 10 miles away will be engaged.—Apply, stating age, experience, and salary required, to L 833, Offices of ENGINEERING.

Draughtsman, Experienced in General Engineering work, REQUIRED by Government Controlled Engineering Company, S.E. London. No applicants residing outside radius of 10 miles or already employed on Government work can be engaged.—Write, stating age, experience and salary required, to L 835, Offices of ENGINEERING.

Draughtsman.—Wanted, immediately, a first-class Engineer-Draughtsman, thoroughly acquainted with general Marine Engineering work. No one already on Government work will be engaged.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and L 860.

Wanted, by Firm on South Coast engaged on munitions work, TWO JUNIOR DRAUGHTSMEN, one of whom should be used to Jig and Tool work. Good wages plus war bonus. Shop experience and theoretical training are essential. The posts would be permanent ones.—Applications, stating age and experience, should be made at your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5532. L 807

Wanted, Senior and Junior DRAUGHTSMEN, experienced in high-class motor and engine details preferred, but not essential.
Also several Jig and Tool Draughtsmen for above work (West London district). State age, experience, salary and when free. Persons engaged on Government work may not apply.
Apply your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and L 783.

Wanted Immediately, for Midland firm engaged on Aero Engine work, Jig and Tool DRAUGHTSMAN as Checker. Good salary and prospect for suitable man. No person already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5428. L 668

Draughtsmen.—A Controlled Establishment in the West Riding of Yorkshire, engaged on important high priority work, REQUIRE the SERVICES of a competent MAN, with first-class experience in General Engineering work; also experienced MAN for medium size machine tool work. No person already on Government work will be engaged.—Apply, stating full particulars, to your nearest EMPLOYMENT EXCHANGE, mentioning A 4965. L 646

A Lady Tracer is also REQUIRED. The above positions are permanent to reliable individuals. No person already on Government work will be engaged.—Apply, stating full particulars, to your nearest EMPLOYMENT EXCHANGE, mentioning A 4965. L 646

Wanted, by National Factory in Midlands, a few DRAUGHTSMEN with experience in machine tool and jig design. No one at present employed on Government work need apply.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and L 751.

Draughtsman Wanted with experience in Motor Vehicle Design, Commercial vehicle experience desired but not essential. Good salary and prospects for man with initiative and right experience. No person already on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, quoting reference No. A 5469. L 747

Draughtsman Required to TAKE CHARGE of Coal Washery Department. Experienced men only need apply.—Full particulars in the first place to R 624, Offices of ENGINEERING.

Draughtsman Required, ac- customed to the Design of Centrifugal Pumps, and preferably with knowledge of Electrical Machinery. Good progressive situation for the right man. No one engaged on Government work or residing more than 10 miles away need apply.—State age, training, and experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and L 443.

Leading and Junior Draughts- MEN REQUIRED, with experience in Electric Crane and Steelworks Charging Machinery, for Westminster office. Good salaries offered competent men. No person employed on Government work will be engaged.—State, fully, experience, age and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning ENGINEERING and L 842.

Crane Draughtsmen.—Leading and Junior Draughtsmen REQUIRED for London district, having either good experience in Steelwork Machinery, Shipbuilding Berth Equipment or General Crane work, although applications from high-class men with other experience would be considered. Permanency for reliable, capable men.
No person employed on Government work will be engaged.—State fully experience, training, age and salary, to your nearest EMPLOYMENT EXCHANGE, mentioning this paper and L 771.

Applications are Invited for the POSITION of JUNIOR DRAUGHTSMAN on the Engineering Staff of a large manufacturing firm in a country district near Bath. Good general experience required.—Address, in the first instance, stating full details of experience and salary required to L 876, Offices of ENGINEERING.

Aeroplane Erectors Wanted, with good experience; also ENGINE FITTERS, with aeroplane or motor experience on engine fitting, REQUIRED for large factory near Liverpool. Also several MEN for laying-out operations and materials, must have Machine Shop and Drawing Office experience. No person already on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5427. L 736

WANTED.

Machine Tool Fitters.— Wanted, at once, three good experienced MEN Machine Tool Fitters for Wheelwrights Department of large Munition Works in North-east London; also several skilled GRINDERS. No person residing more than 10 miles away or already employed on Government work need apply.—Address, L 731, Offices of ENGINEERING.

Chief Timekeeper Required at Cardiff for large engineering concern. State age, qualifications, experience and salary required.—Apply, L 756, Offices of ENGINEERING.

Checker Required for Drawing Office, for checking Jig and Tool Drawings, Gauges and Pictures. Must be thoroughly reliable man. No person already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5404. L 666

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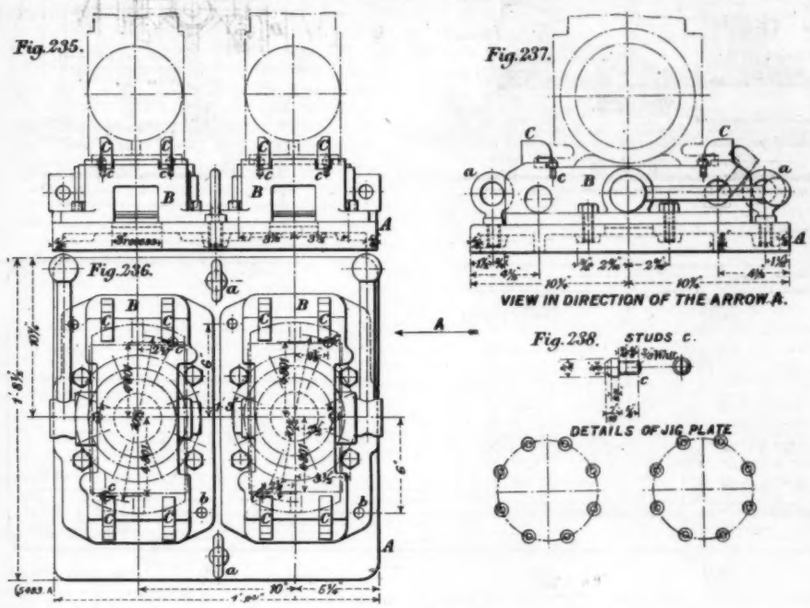
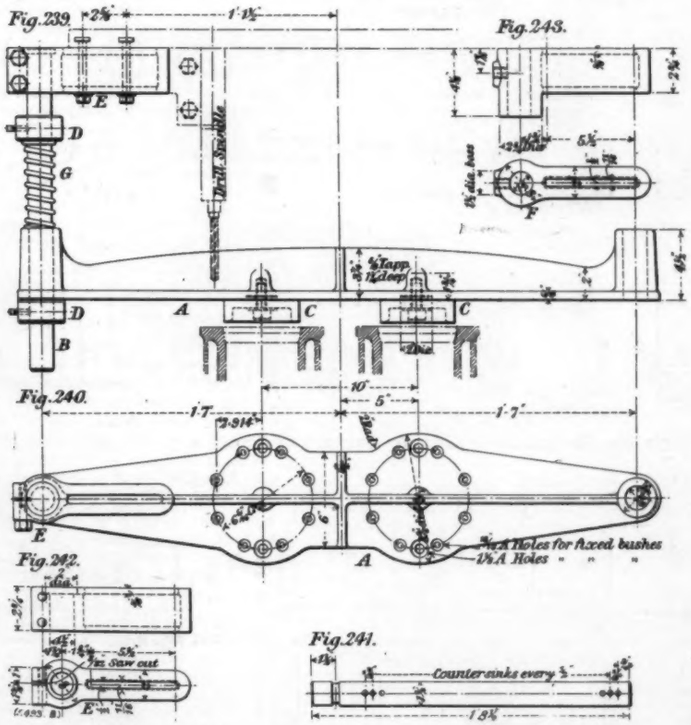
TEMPLETS, JIGS AND FIXTURES.
No. VII.

By JOSEPH HORNER.

THE illustrations in this article are those of fixtures and jigs dealing with engine work by Messrs. Petters, Limited, manufacturers of gas and oil engines, Yeovil. The groups of Figs., 235 to 243, are those of fixtures and jigs for drilling the bolt holes in the tops of cylinders. These include the fixture, Figs. 235 to 238, to which the castings are attached, and the jig, Figs. 239 to 243, through which the holes are drilled. The fixture receives two cylinder castings, the outlines of which are dotted in Figs. 235 to 237. It is made in two parts, comprising a base A, placed on the table of the drilling machine, lifted and lowered with the eyebolts *a*, *a*, and the two portions B, B, bolted down to the base. The exact location of the upper or carrying portion B, B, on the bed A of the fixture is determined by means of taper pins *b*, two to each, at diagonal corners. These holes are drilled with the first or trial cylinders in position and the pins are then sawn flush with the casting. All castings are then located alike. The cylinders seen outlined on the tables have been previously bored, and the flanges faced. They are stood in the fixture by the faced flanges and secured to it with hook bolts C, four to each flange, which bolts fall back to allow the cylinder to be lifted off the locating pins *c*. The locations of the cylinders in their fixture are determined by two locating studs *c*, to each, shown separately in Fig. 238, which enter holes in the cylinder flanges in diagonal settings. These are tapped into the fixture and stand up to pass into the flange.



FIGS 235 TO 238. JIGS AND FIXTURES FOR DRILLING HOLES IN TOPS OF CYLINDERS.



FIGS. 239 TO 242. JIG FOR USE ON A MULTI-DRILLING MACHINE.

The jig, Figs. 239 to 243, used on a multi-drilling machine, is extraneous to the fixture. Its main element is a large drill plate A, of cast-iron supported on two spindles B, B (shown separately in Fig. 241), which are socketed into the framing of the machine. The drill plate is located in the cylinder bores with the steadying bosses C, C, turned to fit the bore and fitted to the drill plate with spigots, and secured with a central bolt. The same drill plate will serve for cylinders of different lengths of bore by the adjustment of the spindles provided with collars D, Fig. 239, each held with a set screw entering countersunk holes which are drilled at equal distance of ½ in. apart along the spindle, Fig. 241. The holes which guide the drills, Fig. 240, are in steel bushes, driven in without collars. The 16 drill spindles D, Fig. 239, receive support from two brackets E, F (compare with Figs. 242 and 243), that are carried on the end supporting spindles B, these brackets each having a long slot hole to receive the adjusting bolts of the arm of the drill spindle.

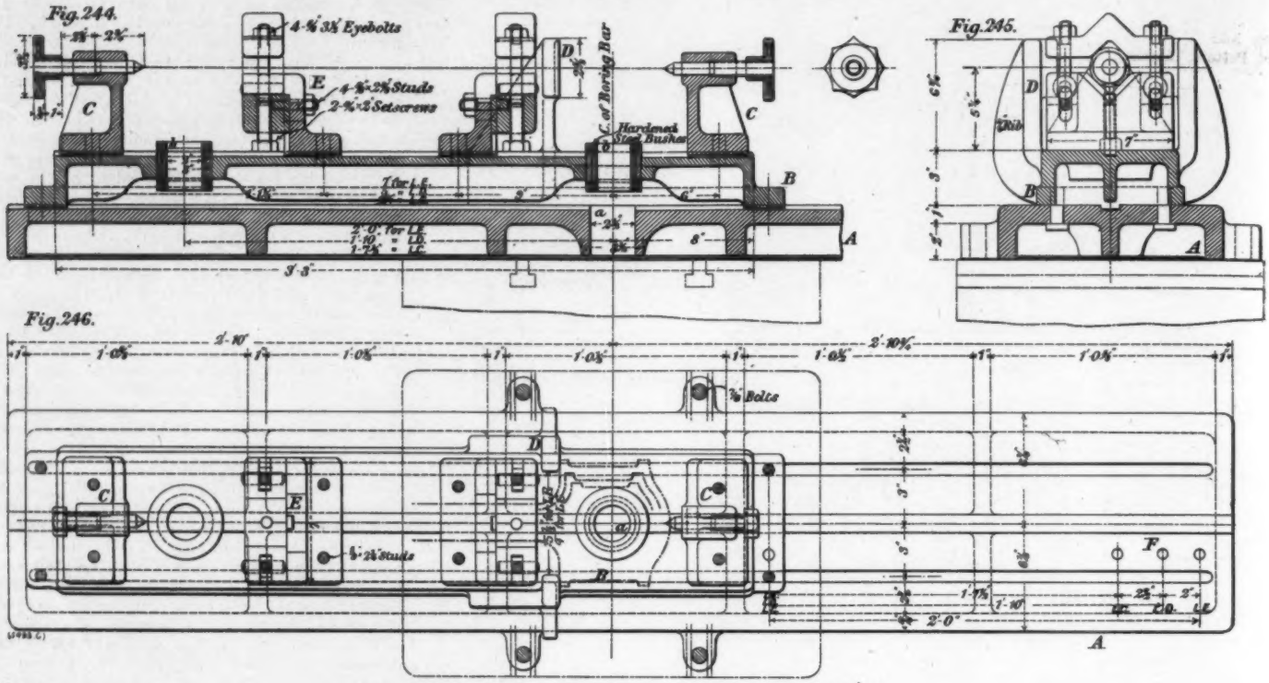
This drill plate, Fig. 240, is used on a 16-spindle multi-drilling machine, the 16 holes being drilled simultaneously. There is no vertical feed on the drill spindles. The table carrying the two cylinders is raised or lowered quickly by a hand lever (the weight of the work and table is balanced by means of a counterpoise) the cylinder faces being forced home against the drilling plate, and against the pressure exerted by the two springs G. The collars D serve to hold up the drilling plate, whilst the cylinders are lowered clear after having been drilled.

After raising the cylinders against the drill plate, the operator applies power feed to the table while drilling the 16 holes. The adjustment on the spindles B for the collars allows for varying heights of other drill plates required for other jobs, the object being to allow the drill points to remain in the guide bushes when the cylinders are removed.

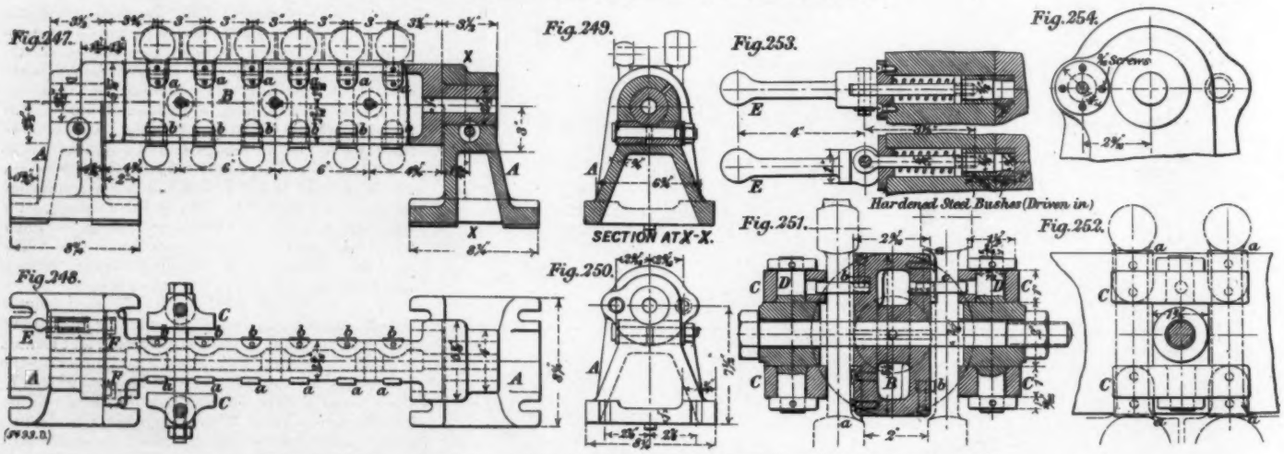
Figs. 244 to 246, page 684, show a boring fixture for connecting rods. A long baseplate A is bolted to the table of the machine, being of sufficient length to permit of the movements of the base B of the fixture in order to bring each hole in the connecting rod under the drill. To allow of this movement the baseplate has two slot holes extending its whole length in which the hold-down bolts slide. The plate has a clearance bolt hole *a* in the centre through which the borings fall. The one baseplate serves for three fixtures to receive three different lengths of rods, namely, 24 in., 22 in. and 19½ in., to the centres of the holes. The rod is centred and located in machine centres C, C, at each end, entering the centres left on from the lathe, and in vee blocks D, E. These latter tightly hold the rod, but do not locate it. The fixture bases B, three in number, are bolted to the base A, but its fittings, machine centres and vee blocks can be transferred to either. There is a solid portion of the fixture base, seen at D, giving longitudinal location of the rod end. The vee blocks each have provision for adjustment for varying heights in the three sizes of rods tooled. They include an angle bracket bolted to the fixture on which the actual vee block is adjusted vertically, for any very slight accommodation, with a set screw. After adjustment, the vee is tightened by two stud bolts which move in slot holes (Fig. 245). When the eyebolts are swung outwards the cap is lifted clear for the rapid insertion or removal of the rod. The bushes *b*, *b*, which guide the boring bar are of rather unusual form. The outer bush remains a fixture. The inner one is loose and interchangeable and is secured in its hole with a circular nut, threaded to fit over the projecting lower end of the bush. The inner loose bush is free to revolve along with the boring bar, the wearing surface being thus protected from any damage likely to be caused through small borings getting between the bar and bush and seizing up, as would be the case if the inner bush were fixed.

An indexing stop is fitted at F (Fig. 246) to give the correct travel required for the sliding table B, a dead true centre distance between the rod ends being

TEMPLETS, JIGS AND FIXTURES.



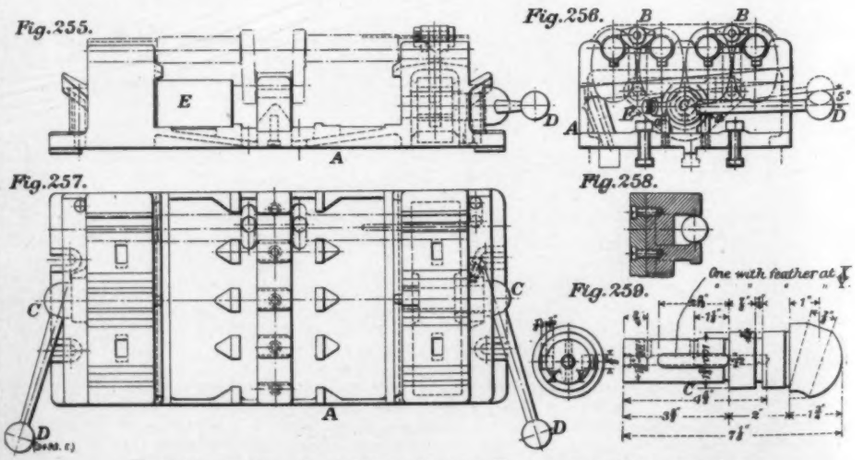
FIGS. 244 TO 246. BORING FIXTURE FOR CONNECTING-RODS.



FIGS. 247 TO 254. FIXTURE FOR MILLING SIDE FACES OF CONNECTING-RODS.

thus ensured in every rod. Accurate alignment and truly parallel faces are ensured by boring and facing both ends of the rod without disturbing its setting, space being allowed on the fixture for facing the underside of the rod end, by a flat facing cutter fitted in the boring bar.

A fixture for milling the side faces of 12 connecting rods held in series is shown by the next group of Figs., 247 to 254. Its elements are two end bearings A, A, in which the actual fixture B, that secures the rod, is pivoted. The rods stand with their stems vertically so that all the ends that are uppermost are being done in series, after which the fixture is turned round 180 deg. to bring the opposite ends uppermost. The positions of the rods are outlined in Figs. 247, 251 and 252. The rods are held in groups of fours between the body B of the fixture and the clamps C, C, Fig. 248. The details of these positions are seen enlarged in Fig. 251, which is a cross-section through the body B and the clamps, and in Fig. 252, an external view looking against the backs of the clamps. The rods are set at one end between locating plates of hardened steel which are screwed on the fixture, seen in the various figures,



FIGS. 255 TO 259. FIXTURE FOR MILLING KEYWAYS IN CRANKSHAFTS.

and at the other against plates that swivel on pins and in concave seatings to accommodate themselves to the rods. Against these locating plates the rods are secured with the clamps C that pivot each on a central pin D to enable them to accommodate themselves to any slight inequalities in the rods which they grip. A stop pin *c* preserves the alignment of the clamps.

The indexing stop pin E, Figs. 248, 253 and 254, is carried in the left-hand end bracket, Fig. 248. It enters either one of two bushed holes in the rotating part of the fixture, Fig. 250, seen enlarged at F, F, Fig. 253. It is seen to comprise a spring pin having a tapered end entering the bushed hole, a collar moving in the spring box, and an eccentric-ended forked handle, by the cam-like action of which the handle is loosed for release and locked during tooling. When the indexing is done the portion B of the fixture is locked securely with a pad bolt, Fig. 249.

The group of Figs., 255 to 258, illustrates a fixture for milling the keyways in four cranks, one of which is outlined in Figs. 255 and 257; while the group of four is shown dotted in Fig. 256. They are single-dip cranks with elliptical webs. A keyway is cut on each end of each shaft. The fixture is a very complete one, since it includes channels for the escape of lubricant and chips, and chip trays for their reception, an excellent provision to prevent messing the machine and the floor.

The main element is a stiff casting A, which has two supports for each crank at the ends, and a central one for the location of the pin. The centre locating piece is screwed to the main casting, see the detail Fig. 258. The cranks lie in concave seatings in the two bearings. The method of holding them is unusual. Instead of vee caps, the clamps B, B, Fig. 256, are used, these being pulled down by an eccentric spindle C and handle D (compare with Figs. 256 and 259), until they take a bearing on two adjacent cranks. This is done in order to get an equal pull on each of the crankshafts as close to the keyways as possible while leaving room for the tools to operate. The clamping is done at both ends, the eccentric spindle being turned through 5 deg., Fig. 256. This operates through an equaliser beam E, connected with links to the clamps which bear on the crankshafts, tightening on them. Studs stop the handles in their lower positions. The main object of the triangular beam is to equalise the pressure on the clamps B when applying pressure on the handle D.

To produce the concave seatings accurately the casting of the jig was made to the dotted line, then bored out and the upper half machined off. Four crankshafts are keywayed simultaneously, the milling cutters being set up on the arbor at the correct spacing.

The provision made for the removal of chips is complete and ingenious. It will be observed that recesses are cut below the seatings for the crankshafts, which slope away to the right and left, Fig. 255. From the end bearings they discharge into shoots on the outside faces which terminate (see the end view, Fig. 256) in a blank end that directs the chips into a diagonal passage leading down to a discharge channel. On the inside faces they fall direct into a chip tray E which is carried on the facings seen in the plan view and in the elevation. The base casting is also sloped towards the centre so that any superfluous stuff is directed into discharge openings in the bottom. Though no tooling is done on the pin yet, the support there is sloped right and left to carry off any oil that may be present, and conduct it to the same discharges.

HIGH PRESSURE IN TUNNEL CONSTRUCTION.—A maximum pressure of 47 lb. per square inch, says *Engineering News-Record*, New York, has been reached in the construction of one of the four new tunnels under the East River, connecting the boroughs of Brooklyn and Manhattan, New York City. The pressure of 47 lb., adds our contemporary, is the highest ever encountered in compressed-air tunnel work, with a single exception. A pressure of 52 lb. was once reached for a very short time in the construction of a gas main tunnel under the East River. Such a pressure would not be used to-day, as it is forbidden by law. When the 47-lb. pressure was reached in the railway tunnel workmen could remain under it only a very short time. The work was done in shifts of 45 minutes each, and only two of these working periods were allowed in each 24 hours. The great pressure was necessary owing to the depth at which the tunnel is being dug, over 100 ft. below the river surface.

THE IRON RESOURCES OF CANADA.

Of various raw products, the resources of Canada are apparently inexhaustible, and the mineral wealth is not inconsiderable, yet up to the present no great amount of iron ore is to be counted among her assets. It would be rash, however, to conclude that the vast Dominion has been niggardly treated in this essential factor in human progress. The trend of development has been mainly agricultural. The task of her scattered inhabitants has been to possess the land, to demonstrate its fertility and possibilities rather than to penetrate beneath the surface in search of a latent wealth, which, if found, could not be made available in distant markets. The activities of her great neighbour and older society on the South, stimulated by the enormous and easily quarried stores of the Mesabi range in the neighbourhood of Lake Superior, have overshadowed what little enterprise she has been tempted to display, and tended to cripple her nascent energies. Canada, however, has to her credit the erection of the earliest plant for the production of iron in America, and for almost two centuries the forges of Three Rivers, Quebec, have remained in nearly continuous operation. The future is also hers, for the unknown remains undeveloped. Of the enormous area that the Dominion covers, it is only in the longer settled districts that any systematic exploration has been undertaken with the view of exploiting the mineral wealth. The imagination fails to grasp the vast extent, possibly one-third of the whole, that remains unexplored, even untrodden, and cannot conjecture its dormant possibilities. The Caribou country north of the Peace River, within easy access of settled regions, successfully hides its own secrets. The still larger unexplored area around Lake Athabasca has to surrender its treasures. From Hudson's Bay, whether we look westwards towards Alaska, or eastwards to Labrador, the map shows that only a few unmethodical attempts have been made to penetrate the unknown. It is important to note, however, that where investigation has been pursued, success more or less pronounced has rewarded pioneering efforts. The explorations in the neighbourhood of Ungava Bay afford a satisfactory instance.

By her development, late in time, Canada enjoys another asset not to be lightly undervalued. She can profit by the example, as she can avoid the errors of older States. Wisely, Canada insists on maintaining control over the natural resources within her authority. Casual, easy, development that would subsequently hamper or prevent large scale improvement is not approved or tolerated. The acquirement of vested interests is regarded with suspicion. In earlier articles we have noticed the jealous watchfulness with which she has promoted the development of her water power on systematic and economic lines, in order to obtain the fullest benefit under given conditions: the methodical and provident inquiries into the extent of the nickel mines: the availability of her coal measures: the careful stocktaking of her marbles, building stones, &c., and now we note with satisfaction, the same prudent foresight extended to the collection of information concerning the quality, distribution and economic value of her iron ores, with also readiness to afford accurate data to those interested in the iron-mining industry. This information is presented in a report* issued under the authority of the Department of Mines. Of the two volumes the first is devoted to the description of the principal ore mines, and the second to a discussion of the known occurrences of iron ore in general. Numerous detached large-scale contour maps assist the explanation, and the whole constitutes a very efficient inquiry into the past achievements and future possibilities of the iron-mining industry, in Canada. The compilation of such a report is not a light undertaking. It has occupied the Department of Mines since 1903, when the present Director of the Mines Branch, Dr. Haanel, recognised the importance of obtaining a full knowledge of the iron resources of the country. From that date numerous maps and bulletins have been published, and many investigations in particular localities have been made. All trustworthy sources of information have been carefully sifted, and precise statistics collected, first by Mr. Lindeman and later by Mr. Bolton, affording an easily accessible summary of much recondite matter.

A feature in the report is the extent to which the method of magnetometric surveying has been adopted in the mapping of deposits of magnetite. More details of the process employed might have been given, for the benefit of those whose theoretical acquaintance has not been improved by actual experience in the field. Great confidence is placed in the results derived, and to judge from the magnetometric maps attached, this confidence is not misplaced. Doubtless the magnetic deflections have been compared with the results obtained from direct measurement, for in no other way does it seem possible to eliminate the various sources of error that would exercise a misleading influence on the conclusions. It is reassuring to know that erroneous impressions regarding the continuity and extent of the magnetite deposits have been removed, and more definite knowledge acquired. In Sweden, where the overburden and surrounding conditions occasionally resemble those in Canada, very satisfactory deductions have been made, and in adopting the plan one of the objects sought was to familiarise the Canadian engineers with a process that had met with general approval in Scandinavia. It is further claimed on behalf of magnetometric surveying, that the method gives more definite information concerning the extent, shape and value of the numerous known deposits of magnetite than could be obtained in any other way: that the maps made in the course of the survey would be of service as guides in subsequent exploitation and development of selected deposits: and that the work would not overlap but be entirely supplementary to that of other investigators.

Such a plan especially appeals on the ground that it utilises an organised and systematic effort to meet an industrial necessity of extraordinary scope and complexity. Economic geology is better equipped and in a better position to solve the problem of the genesis of mineral deposits. The lines of demarcation between the fields of pure and applied geology are rendered less distinct, and the study of local structure is seen to react with advantage on the general problems of geologic philosophy. The combination of the engineer and the pure scientist in the preliminary work of locating ore beds is most happy, and is the counterpart of similar tendencies in other fields of scientific research. That science should obtain a sure foothold in the domain of practical industry is due not so much to the progress of science, as to the gradual changing conditions throughout the world. Circumstances have accelerated the advent of science, but its influence for good cannot be overrated.

That Canada has need to adopt scientific and organised methods to prevent the exhaustion of the more superficial and easily mined ore bodies, and to make secure a system of replacing these from other home centres, may be inferred from an important table that the compilers have prepared, comparing the annual production of iron ore in the Dominion and the quantity charged to the blast furnaces. This table shows not only that the home production has been practically stationary for many years, but that the percentage of mined to imported ore has been steadily diminishing. The output has not increased with the demand. This table goes back thirty years, but since 1896 when accurate statistics became available, in the direction intimated, the data do not point to a satisfactory conclusion. They show that large imports have been made from the United States with corresponding diminution of the home product. The "banded jasper" ironstone formation in the region of the Great Lakes affords a facile source of supply, that operates adversely on home energies. Newfoundland also finds a market for her excess output, but much of this is owned and mined by Canadian companies, and in any case the traffic assists a sister Colony. In considering these facts, it is well that we should remind ourselves of the very pertinent fact that for twenty years or more the weight of

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* "Iron Ore Occurrences in Canada." In two volumes. Compiled by E. Lindeman, M.E., and L. L. Bolton, M.A., B.Sc. Introductory by A. H. A. Robinson, B.A. Sc. Ottawa: Government Printing Bureau, 1917.

metal imported into this country has been in excess of the quantity smelted from ores wrought in British mines and quarries. The easier system of free imports has been followed here. We can only reproduce the statistics for a few typical years, but such a curtailed table is not uninstructive :—

Year.	Production of Iron Ore. Short Tons.	Iron Ore Charged to Canadian Blast Furnaces.		Per-centage of Canadian Ore in Total Ore Charged.	Ratio Canadian Production to Total Ore Charged Per Cent.
		Canadian Product. Short Tons.	Quantity Imported. Short Tons.		
1887	76,330	60,434	—	—	—
1896	91,906	96,560	46,300	67·6	64·3
1897	50,705	53,658	55,722	49·0	46·3
1902	404,003	125,664	559,381	18·3	58·9
1903	264,294	82,035	485,911	14·4	46·5
1910	259,418	149,505	1,377,035	9·8	17·0
1911	210,344	67,434	1,628,368	4·0	12·4
1912	215,883	71,588	2,019,165	3·4	10·3
1913	307,634	139,436	2,110,828	6·2	13·7
1914	244,854	182,964	1,324,326	12·1	16·2
1915	398,112	293,305	1,463,488	16·7	22·6
1916	339,600	221,773	1,964,598	10·1	15·5

From the above figures it is evident that twenty years ago, Canada produced twice as much ore as she imported, and the exports were small, amounting to less than 5,000 tons. The percentage relation between the quantities produced and smelted dropped to 14·4 in 1903, owing to the large increase in imports. After some minor fluctuations, but evidencing a tendency to continual decrease, the figures reached show that Canada did not care to smelt her own ore. The maximum raw output, 404,000 tons, occurs in 1902, but for several years after that date the mean annual production was little more than half this quantity. The demand due to war requirements has increased the smelting industry, without increasing the amount of imports. The quantity imported reached its maximum in 1913, and though the earlier years of the war show a decline, this figure is likely to be soon again reached. The total production of iron ore in Canada in 1916, the last year for which statistics are available, was equal to only 15 per cent. of the total ore smelted in Canadian blast furnaces. About one-third of the home product was exported.

The absence of a market for ore produces similar conditions to those that follow from the absolute lack of ore bodies. The stagnation may be temporary, but while the demand is wanting there is little inducement either to develop known sources or to search for new ones. The iron industry in British Columbia illustrates this feature. The country is rich in ores, feeble efforts at times have been made to utilise the mineral wealth by exporting it to Washington Territory, but such trade has been spasmodic, and throughout this vast province the present production is negligeable. Smelting facilities are wanting, but magnetite, hematite, limonite, and clay ironstone exist in abundance and are well situated for cheap mining and easy transport. But private enterprise is hampered and capital is not attracted. The necessary stimulus can only be supplied by Government action, since an adequate remunerative return can hardly be expected for some years. The Government is exercising its proper function in instituting practical inquiries, and is showing commendable foresight in disseminating accurate information.

Fortunately, in the matter of prospecting, there is an encouraging tale to tell. On the coast of Vancouver, and on the islands in the Straits separating it from the main land, great mineral wealth is awaiting exploitation. The Island of Texada in the Straits of Georgia, an elongated and steeply flanked ridge, consists of a mass of porphyrite of the Lower Jurassic Age. On its surface are three adjacent deposits known as the Prescott, Paxton, and Lake mines, which together have a tonnage estimated at 4,500,000 tons, and there are good grounds for suspecting that the concealed portions are larger than the small outcrops indicate. The assays, especially in the amount of metallic iron, are very satisfactory, and the phosphorus content is well under the Bessemer limit, as the table in the next column clearly shows.

The copper content is usually small, but in some Columbian deposits the quantity of copper present in the form of chalcopyrite is so great, that the ore may be regarded as one of copper rather than of iron. Here, as elsewhere, along the Vancouver coast, sulphur contained in iron sulphides, pyrite and pyrrhotite is the principal deleterious impurity. Under present conditions, special treatment, as roasting, would be necessary to make much of the ore fit for blast-furnace use, but on a spot favourable for transport, where ore, fuel, and flux material are found in juxtaposition, it is highly probable that in the near future the ores will be smelted locally, though labour conditions are said to be unfavourable. The Canadian Government are prospecting in advance, when world shortage may compel unexpected industrial developments and improved metallurgy demonstrate more economical methods of treatment. The general outlook points to the possibility that remote outlying dependencies will feed the British and European markets with manufactured, or semi-manufactured, metal.

—	Prescott Ore-body, Lower Tunnel.	Paxton Ore-body, 45 Ft. Tunnel.	Lake Ore-body, Average of Ore.
Silica	4·37	4·47	8·33
Iron	63·27	64·48	59·57
Alumina	1·18	0·66	1·71
Lime	2·58	1·32	3·82
Magnesia	1·05	1·13	1·05
Copper	0·09	0·22	0·08
Sulphur	0·347	1·866	0·137
Phosphorus	0·007	0·003	0·032

On the mainland the outlook is equally promising. At the Glen mine in the neighbourhood of Kamloops, magnetite has been worked intermittently. The ore is of excellent quality, yielding over 60 per cent. of iron, with low sulphur and phosphorus content. It is thought that 8,000,000 tons will ultimately be mined, but the development work is not sufficiently forward to admit of exact estimates. Deposits of hematite are known, but are small in amount and too widely scattered to possess any great economic importance. Limonite and bog ore deposits, apparently of large extent, have also been encountered. In one area the quantity is estimated at 7,500,000 tons, but here again development work does not warrant any trustworthy estimate. The proved amount of ore generally is certainly hopeful, and if no great ore bed like the Minette series of Lorraine or the Mesabi range of the Great Lakes has been discovered, British Columbia will from its own stores be able to supply its own needs, and probably satisfy the demands of Western Canada as Newfoundland can the Eastern Section.

In the agricultural provinces of Alberta, Saskatchewan and Manitoba, little ore has been found, and little interest is taken in seeking new sources, at least in the more southern portions. Hematite is reported on an island in Lake Winnipeg, but apparently not in sufficient quantities to repay the cost of transport. In Alberta, ore-bearing beds having a thickness of 10½ ft. have been reported, that yield about 40 per cent. of iron, but have 5 per cent. of titanic acid. In their natural condition, such ores cannot be regarded as suitable for blast furnaces, but it is suggested that magnetic concentration might furnish a commercial product of some value. Prospecting shows fairly conclusively that the middle West Provinces, at least south of the 54 parallel, cannot be regarded as an iron country.

Ontario, to the east of these territories, can claim the largest production of iron ore throughout the Dominion. Production has been fostered by a system of bounties, and exploration has been stimulated by the similarity in geological formation with that of the iron ranges of Minnesota. This eagerness is attested by the long catalogue of small mines described in the second volume. In no less than 15 centres iron has been found, and each of these centres is subdivided into many disconnected beds. Wide distribution rather than useful concentration has been the outcome of this untiring prospecting, and it is to be feared that but an indifferent reward awaits the industrious prospector. The total length of the superficially examined beds must extend to hundreds of miles, but the iron content seldom exceeds 33 per cent., and the admixture of local rock and often of sulphur renders commercial working difficult. As a rule, the magnetite occurrences are outcrops of banded iron formation. Narrow bands of magnetite alternate in distinct layers with chert and jasper. The compilers of this excellent report do not view the situation very hopefully. The reports of the existence of hundreds of millions of tons of ore of the Lake Superior type still lying undeveloped in Ontario, are rather ruefully recalled as a disappearing myth, and it is added: "Even under the most favourable conditions only a small fraction of the iron in these formations is likely to be in ore of commercial grade. In Ontario, much money has been spent in exploring them, but so far, only at the Helen and Josephine mines, have secondary concentrations of the iron to high grade ore bodies of commercial size been found associated with them." The prospect is held out that magnetic concentration might be adopted with advantage. Recourse would be had to crushing, concentrating on magnetic separators and sintering the concentrates on a Dwight-Lloyd machine, and by such means obtaining a high grade porous product, with low sulphur content, fitted to blast-furnace use. The misfortune is, that none of these scattered mines has large enough output to warrant the erection of a plant of sufficient capacity to ensure economic working. It might be possible, by collecting the output of a number of properties at some central station, to work a concentrating plant, but an unfortunate practical example does not encourage experiment in this direction. At Moose Mountain, an attempt at concentrating and sintering ended in a dismal failure. The ore at that deposit is of two types, a massive magnetite from which a marketable concentrate, carrying about 55 per cent. in iron, could be obtained by magnetic cobbing, but when it became necessary to utilise the ore of the second type, a fine-grained banded siliceous magnetite, of perhaps 40,000,000 tons in extent, such difficulties were encountered, that the plan had to be abandoned. This was the more disappointing as on an experimental scale, a good separation of magnetite from gangue could be effected by very fine grinding, followed by magnetic concentration on Grondal separators. This concentrate when briquetted and sintered carried 65.6 per cent. of iron and was admirably adapted for blast-furnace use: 2·1 tons of crude ore being required to give a ton of concentrates. But when applied on a commercial scale, the process proved unsuccessful and in 1915 the mine was shut down.

The want of a commercial plan for treating the lean siliceous magnetite of the iron formation is the problem of the hour. The cost of mining, crushing and concentration, and of briquetting increases the working charges to such an extent, that it is doubtful if the low grade ores could be profitably worked on the largest scale. Some simpler and cheaper plan is imperatively needed, and this need will be more pressingly felt when the Helen mine, whose exhaustion is regarded as imminent, ceases to yield. The brown hematite from this mine has been the mainstay of the Ontario output, and consequently that of Canada. The ore is of high grade and good quality, the main drawback in working being the presence of pockets of pyritic sand, increasing in number with the depth. This sand has had the effect of raising the sulphur content, and a large tonnage of ore has had to be left in the mine on this account, but the history of the mine is satisfactory. The problem of replacing it, though urgent, is not easy of solution. Little hope is entertained of discovering new ore bodies by superficial examination, and recourse to diamond drilling and underground exploration presents special difficulties.

If the mining industry in Ontario causes some anxiety, the conditions are still more depressing in Quebec Province. At Three Rivers, once an active centre of mining, as it was the oldest in operation, the mines, after being worked fitfully were finally shut down in 1911, and in the last three years the output throughout the entire province has been nil. The history of the Bristol mine on the Ottawa River illustrates the decadence that has overtaken similar undertakings. In 1872, an American syndicate hopefully leased the concession, but progress was so slow that the lease expired before any ore was shipped. In 1884, another syndicate started operations; roasting kilns were

set up, the necessary shops erected, and for a while prospects looked more flourishing. But ten years later, after several interruptions, the company went into liquidation. "Since that time no attempt has been made to reopen the mine, and at present all the workings are filled with water." Yet there is iron ore there, carrying from 53 per cent. to 58 per cent. of metal. Sulphur is there, too, but a high and unobjectionable concentrate in iron is possible by the nodulising or sintering processes. No estimate can be made of the life of the mine under working conditions, but magnetite beds are so frequent and the inclosing rocks are so impregnated with disseminated magnetite, that the whole deposit could probably be worked. The history of the Forsyth mine is somewhat similar, though here diamond drilling has certainly proved the existence of some 430,000 tons of concentrates, and no special treatment seems to be necessary for reducing the percentage of sulphur. Urgency and improved metallurgy seem necessary to revivify the ancient activity.

Titaniferous magnetite which, though not at present marketable as iron ore, may become of commercial importance, occurs in large quantities. One deposit is estimated to contain 5,000,000 tons. The ilmenites which, like the titaniferous ores, occur as basic segregations in anorthosite, are much in evidence, and at some mines the ore has been profitably employed in the electric furnace for the production of titanium alloys. It is to be regretted that hematite is very scarce, and that the occurrences are too small and unpromising to be of interest to the smelter. Bog ores that furnished the excellent and earliest pig-iron in the Colony—charcoal being employed for the fuel—are of wide occurrence, and at times efforts are made to work some of the individual deposits, but none has achieved commercial success. A somewhat unusual source of iron has been found in the black sands that accumulate on the north bank of the Saint Lawrence. These sands are found in an area of grassy dunes, the width of which averages 500 ft. No attempt has been made to utilise this source commercially, but it is thought that some 500,000 tons of magnetic concentrates of 67 per cent. of iron could be made available. This account does not offer a very exhilarating prospect for the future of an important industry. Fortunately there is hope that a brighter note may be sounded from the northern portion of the province, towards Ungava Bay, and in even remoter regions where sedimentary rocks including low-grade bedded deposits of magnetite, hematite and jasper are known to occur—the formation having a striking resemblance to the Animikie rocks of the Lake Superior iron ranges. The inaccessibility of the district has prevented any systematic exploration, and even if the most extravagant hopes are fulfilled, for a long time to come transport will offer great difficulties. But if, as we are told, hundreds of millions of tons of ore are in sight, on the Koksoak and Swampeybay Rivers, means will be forthcoming to make such stores available, and thus provide a fitting compensation for all the minor disappointments in lower latitudes.

New Brunswick, though in the past capable of supplying its own needs, has never been a prolific producer, and its mining industry has known many vicissitudes. Its staple product consists of a fine-grained siliceous magnetite, intermixed with hematite. The iron content varies considerably from 35 per cent. to 59 per cent., but generally the ore is of too low a grade to be marketed in its natural state. Concentration has generally been adopted, but selective mining, or only stoping the richer ore, might be followed with advantage. Bathurst, which may be regarded as the centre of the local industry, has known periods of prosperity and depression, and in the last few years stagnation has ruled. It is hoped, however, that better times may return, for magnetometric surveys and boreholes have shown that some 20,000,000 tons might be extracted, and that even this amount could be increased from neighbouring deposits. Much preliminary work has been done by constructing railways and docks to facilitate transport. Ocean-going vessels drawing 21 ft. can dock alongside the wharves, and loading capacity up to 3,000 tons an hour has been provided. With favourably situated deposits, and with such facilities, it is not impossible but that mining will be revived.

Nova Scotia has yielded a fair supply of iron, and next to Ontario has been the largest producer in the Dominion. Its mines are now idle and its blast furnaces cold, except they are fed from the Wabana field of Newfoundland. Its early promise has not been fulfilled, and the history of the industry suggests a doubt that some of the rosy-hued prospects, so alluringly displayed in other provinces, will fail to realise. In early days glowing reports of prospectors told of large resources and hinted that a prosperous mining industry must result. But, to quote Mr. Robinson, "the better the deposits became known the more they shrunk in volume and declined in quality; and we must attribute these earlier claims to the undeveloped state of the country, and the natural optimism of early explorers in a comparatively unknown region." There is now little use in describing areas that have been exhausted, though a valuable limonite and hematite found in slates and quartzites long fed Nova Scotia furnaces. It may be recalled that it was in Acadia with such raw material, that Dr. Siemens made his first commercial experiments on the direct conversion of iron into steel. Plenty of the ore can still be found in the Ordovician rocks, but of too low a grade in iron, and too siliceous, to be profitably worked. The most promising iron field is in Annapolis County where two workable beds of hematite are known to exist but at present do not form an attractive proposition. Concentration plant has been erected to bring the ore up to merchantable grade, but the concentrates have no very favourable analysis, iron running from 50 per cent. to 52 per cent., silica 13 per cent., phosphorus 1·32 per cent. and sulphur 0·015 per cent. respectively. Magnetic concentration has not proved satisfactory on account of the percentage of hematite, and since 1913 extraction has stopped.

Although the Mines Department of Canada has no control over the management and development of the Newfoundland ore deposits, yet in surveying the iron resources of the wide area from the Pacific to the Atlantic, to omit all mention of the far eastern Colony, would be akin to producing Hamlet without the Prince. For here, where the new Continent makes its closest approach to the old, thus aiding distribution in both hemispheres, Nature has been in her most lavish mood and stored up reserves that dwarf to insignificance the sparingly supplied ore beds on the mainland. Bell Island, in Conception Bay, is so small that it can hardly be seen on the map, but on its shores and in its submarine extension is one of the largest and most compact collections of two important iron-bearing minerals, hematite and chamosite. The yield of iron is 53·86 per cent., and as phosphorus is 0·850 per cent. the Wabana ore is of a non-Bessemer grade. A moderate computation places the content of iron at 4,000,000,000 tons, but the life of the mine is more likely to be determined by the working conditions that obtain in the future, than by the process of exhaustion. When the ores of Bilbao and the metasomatic hematite masses in the Pyrenees fail, when the famed Minette series of Lorraine, whose possession tempted the cupidity of Germany, ceases to be remunerative, the Wabana ores of Newfoundland, will still be playing a worthy part in promoting the culture and civilisation of the world. Further, the utilisation of such a mass may revolutionise the processes of metallurgy. As Eckel has pointed out, the submarine stores of Newfoundland "may be the most important single factor in our next stage of progress, for, as soon as an ore-holding reaches a size to justify changes in metallurgical practice or plant location, its ores acquire a technical and moral value far above that which they would have if merely sold on a competitive basis in an open market."

THE POLYTECHNIC SCHOOL OF ENGINEERING.—The Hon. Sir Charles A. Parsons, K.C.B., F.R.S., has consented to fill the office of president of the Polytechnic School of Engineering, Regent-street, W., in succession to the late Mr. Charles Hawksley, past-president of the Institution of Civil Engineers. The first president of the school was Professor David Hughes, F.R.S., the founder of the Hughes medal of the Royal Society.

RESERVOIR DAMS.

IF the engineer could place a reservoir dam where he chose, after carefully examining the site by means of borings, the work would be comparatively simple. The art of building dams, even of masonry dams, is theoretically simple, and there is a great mass of practical data to justify, or to correct, the theoretical considerations. But, unfortunately, the site of a dam is fixed by the site of the reservoir. As to the latter, there is seldom much choice. The gathering ground, the river, or the lie of the land, generally point to one place, and to one place only, where a reservoir can be economically constructed, and the position of the dam is fairly defined by the same facts. Hence, it follows that the engineer must build his structure at, or near, a given spot, and he must face all the difficulties of the situation as best he can. This does not mean, however, that he can take any chances and be satisfied with something less than perfect security. The impounding of thousands of millions of gallons of water at a high level creates a force which, if not under complete control, may bring disaster to miles of country lying below. It would be easy to adduce several examples of the effects of bad design in this respect, and the writer has a vivid recollection of the condition of the Don Valley the day after the Redmires Dam of the Sheffield waterworks gave way, when several villages were swept out of existence. That, however, is a long time ago, and now masonry dams are among the safest and most reliable of engineering structures, thanks to our growing knowledge, and to the meticulous care engineers spend over every detail.

As an example of a most difficult—and successful—piece of dam construction, we give in our four Plates, Nos. LIX. to LXII., and on page 689, photographs and drawings of two great dams built in connection with the Derwent Valley Waterworks to the design, and under the immediate superintendence of Mr. Edward Sandeman, M.Sc., M.Inst.C.E. These are known respectively as the Howden Dam and the Derwent Dam, and their positions are shown on the map, Fig. 1, page 689, which represents a portion of Derbyshire traversed by the Midland Railway between Matlock and Buxton. These two dams are very similar in design and appearance, the differences lying in dimensions only. Their cross-section is given in Fig. 5, page 689. The lengths on the top water line are 1,080 ft. for the Howden Dam (Fig. 4, page 689, Fig. 6, Plate LIX, and Fig. 8, Plate LX), and 1,110 ft. for the Derwent Dam, while the heights above the river bed are 117 ft. and 114 ft., and the widest part of the foundation are 117 ft. and 114 ft. respectively. Practically, they are alike, the only difference possibly noticeable to the eye is that the central overflow weir is 500 ft. in length in the Howden Dam, and 600 ft. in the Derwent Dam, the latter, being lower in the valley, having, naturally, to pass the greater quantity of water. The compensation water to be given to the River Derwent was fixed by referees appointed by Parliament at 15,209,000 gals. per day.

The geological formation of the valley, even if it had been good of its kind, was not ideal to carry a great dam. The tops of the hills are millstone grit, which is a very serviceable rock, but it is all above the level of the excavation. Below it comes the Yoredale rocks, which are a miscellaneous collection of beds of shale, alternating with beds of sandstone, the former ranging from several feet to a few inches in thickness, and the latter usually less than 2 ft. in thickness, but occasionally attaining 7 ft. to 8 ft. Unfortunately, the strata had suffered great disturbance in the past. Generally they were bent, but in the bottom of the valley the pressure of the adjacent hills had forced them to slip forward and to up-heave in a dangerous fault, as shown in Figs. 3 and 4, page 689, and in Fig. 11, Plate LX. It was on the very worst part of the faulting that Mr. Sandeman had to build his dams of more than 100 ft. in height. The valley sides, although not folded like the bottom, are, nevertheless, very disturbed and cracked, and have no pretentions to be watertight. A reservoir dam is, of course, rarely pushed over by direct pressure. If it fails, it is generally by the eroding action of water leaking under the foundation, or around the ends, where they are built into the side-hills. Under a pressure head of

more than 100 ft., a trick'e will soon bore for itself a wider passage, and admit a greater stream, which, in turn, will en'arge the opening, and so the process goes on in a vicious circ'e. On strata such as shown in the sections and photographs, it was a task of very great difficulty to prec'ude all chance of leakage, and the means adopted entailed much labour and great expense. Probably, no dam was ever built that was absolutely tight, the engineer having always to compromise between ideal and commercial conditions. It is just on this point that skill and experience come in.

In the centre of the Howden Dam the excavation of the foundations was carried down to 70 ft. below the ground, and even at this level the strata were not watertight, although they were quite capable of carrying the structure. There was no promise of immediate improvement if a lower depth were sought in the same way, while the increase in cost, due to the rapid extension of the width of the base (Fig. 5, page 689) was a very serious consideration. Mr. Sandeman, therefore, decided not to attempt to get a watertight joint between the masonry and the ground, but to sink an apron or curtain wall of moderate thickness to such a depth that it should rest on solid strata, or, at least, on strata under such pressure from above that percolation would not be dangerous. A trench, 6 ft. wide, was, therefore, carried down a further 55 ft. (Fig. 12, Plate LX) and filled with concrete to form a water-tight barrier. This trench extended the whole length of the dam, and ended in the east hillside at a depth of 190 ft. below ground, and on the west at a depth of 115 ft. The height of the dam from the deepest part of the main trench to overflow level, is 187 ft., and from the bottom of the narrow trench to overflow, 242 ft.

Security from leakage under the dam having thus been obtained, the ends had to be made tight. The usual plan is to carry the dam into the hills and to grout it into the firm rock. But headings driven several hundred feet into the hillside failed to find solid ground. The rock was broken up, and wide crevices existed, through which the water of the reservoir could have flowed in streams, probably exposing the flank of the structure, and making a new path for the river (Figs. 9 and 10, Plate LX). It was, therefore, decided to carry two wing walls at right angles to the dam, and roughly parallel to the sides of the reservoir. The wing well at the east side is 2,860 ft. long, and that on the west side, 2,600 ft., of which 1,007 ft. were tunnelled. The trenches are 5 ft. 8 in. wide, and are filled with 5 to 1 concrete. The total quantity of concrete in the east wing trench is 75,126 cub. yards, and in the west wing trench, 61,519 cub. yards.

There was a curious similarity in the conditions in the two dams, although they were some three-quarters of a mile apart. In the Derwent Dam, the main foundations are 60 ft. below the river bed, as compared with 70 ft. at Howden. The 6-ft. trench or curtain well is carried down a further 38 ft., or 98 ft. in all. The height of the dam from the deepest part of the narrow trench to overflow level, 212 ft. The trench extends the whole length of the dam, and is carried into the hill on the west side for a distance of 605 ft., and on the east side for 792 ft. At the west end, the trench terminates at a depth of 42 ft. below the river bed, or 156 ft. below the water-level of the reservoir. At the east end, the deepest part of the trench is 108 ft. below river bed, and 222 ft. below water-level.

The conditions of the wing walls in this reservoir were quite different from those at Howden, and the engineer had to find another method of meeting the danger of infiltration. There was much more shale in the ground, and, further, it was loose and broken by numerous slip faults. The sandstone beds were in a very similar condition, and had no appearance of watertightness. Examination showed that the strata dipped upstream from the dam, but down-stream they ran nearly level, having a slight dip with the valley on the west side, while, on the east side, they rose slightly downstream. A cross-section of the valley showed a rise of 1 in 50 approximately into the west hillside, and a dip of 1 in 17 into the east hillside. On the east side the strata were crossed by numerous faults at a vertical angle of, roughly, 60 deg., lying about N.W. and S.E. on plan (Fig. 1), but, further, they changed in direction to about N.E. and S.W. On the west side of the valley, they ran, approximately, N.E. and S.W. The downthrow of these faults, on both sides of the valley, was generally towards the middle of the valley. Mr. Sandeman, therefore, determined to carry the wing wells direct into the hills, in continuation of the dam, and not at right angles to it, as at Howden. As already stated, the east wall was longer than the west, and proved to be a work of much difficulty, owing to the rapid dip of the strata into the hillside, and the great amount of water met with. Both here and on the west side the ends and bottom of the wing trenches were carefully grouted with cement under pressure.

The building of the dams was done piecemeal, as shown in Fig. 6, Plate LIX., and Figs. 13 and 14, Plate LXI. A portion of the ground was excavated, and a large mass of masonry was laid down. In this was built, at the Derwent Dam, a culvert 19 ft. in diam., large enough to take the river, and then the river was diverted through it, leaving all the rest of the valley free for further building operations. The culvert at the Howden Dam was 17 ft. in diam., and the river was not diverted until the dam was built. The building of the dams went forward from the exposed face of the masonry, and gradually progressed across the valley, great care being taken in jointing the new portion to the exposed face. The concrete was 6 to 1 in the base, 5½ to 1 in the middle, and 5 to 1 in the upper and thinner part of the structure. In it there were placed large rough blocks of quarried millstone grit, from ½ ton to 6 tons in weight. These were got from a quarry containing a bed known geologically as the Rivelin Grit. The quarry was near the Midland Railway, between Hathersage and Grindleford, and an incline (Fig. 18, Plate LXII) was constructed to connect it to the railway. This was on a gradient of 1 in 3, and was worked by ropes connecting the full and the empty trucks, and passing round a large drum. This quarry could deliver 6,000 tons a week. In addition to the large stones, the quarry provided rubblestone, which was loaded in boxes of 3 tons capacity.

The sites of the dams were each spanned by cable-ways capable of lifting 6 tons. The cables were composed of steel wires 0·156 in. in diam., with an ultimate strength of 3,270 lbs., and the circumference of the cables was 7 in. At each trench there were two cable ways, and each could be traversed side ways at one end (Plates LIX and LXI), so that it commanded a triangular piece of ground, and as the movable towers were on opposite sides of the valley, the result was that a rectangular piece of ground was covered. The fixed end of the cable passed over a wooden tower, and was anchored to a concrete block in the ground; the other end was attached to a travelling tower, with a counterweight. These ropeways were used both for excavation work and also for bringing the concrete into position. The large stones were brought in wagons, and after being washed, were lifted into position by cranes running on elevated roads carried on piers (Fig. 13, Plate LXI) which were eventually built into the dam.

The compensation water to be given to the river in respect of the portion of the water-shed controlled by the Howden and Derwent reservoirs amounts to 6,600,000 gallons per day, and it is discharged at the foot of the Derwent Dam. The water to be delivered for town use, passes through the Howden Dam by two 36 in. pipes in the east tower, and through the Derwent Dam by three 45 in. pipes. In each dam there are six 30-in. discharges, three in each tower, for emptying the reservoir and for scouring purposes. All these pipes are controlled by valves worked from the towers. The main pipes lead to the filter beds at Bamford, and after the water has passed through them, it is conducted by an aqueduct 28 miles in length to the Ambergate service reservoir. This aqueduct consists of 17 miles of cast-iron and steel pipes, 7 miles cut and cover, and 4 miles of tunnel. For a part of its length it is carried on arches, alongside which a road bridge has been built (Fig. 16, Plate LXII). The cut-and-cover portion consists of a circular culvert 6 ft. 3 in. in diameter (Fig. 17, Plate LXII.) and made of concrete, having an internal lining of blue brick 4½ in. thick, with ½ in. of cement mortar rendering between the two. The cement is 9 in. thick, with haunches to support the arch from the trench side. The gradient is 1 in 4,000, and when the water is 4 ft. 9 in. deep, the estimated delivery is 35,000,000 gals. a day.

In order to ascertain what proportion of the rain-fall flowed off the drainage area of 31,000 acres, and to obtain data as to the dry-weather flow and as to volume of floods, a weir (Fig. 15, Plate LXII.) was erected on the River Derwent, above Bamford, from which records have been collected since 1906.

The two dams described afford excellent examples of the great responsibility cast upon an engineer who has to build such structures at points determined for him by the contour of the country. The need of unremitting care is seen by the constantly varying nature of the ground, and when every care has been exercised there still remains grave anxiety as to whether there may not be disturbing conditions not revealed by the borings. No one can undertake such a work unless fortified by a wide experience, but experience alone is by no means sufficient for the task, for new features are always revealing themselves, and must be met by new methods or new construction. A compromise has always to be made between lavish expenditure to attain perfect watertightness, and the taking of small risks in the first instance, with the certainty that these can be dealt with later if they should prove more serious than was anticipated. For instance, water began to appear on the site of the Derwent Reservoir when the Howden Reservoir was filled. Its quantity was later reduced to one-half when the Derwent Reservoir was filled owing to the gradual silting up of the underground strata. Part of the percolation is attributed to the fact that the wing trenches were constructed along the foot of the hillsides, preventing the drainage of the country immediately contiguous from entering the upper reservoir. Mr. Sandeman carried out the construction of the reservoirs by administration, and hence he had not the advantage of the help of a skilled contractor. He gave a full account of the entire works, including the filter beds, and the service reservoir in an interesting paper read in the session 1917–18 before the Institution of Civil Engineers. In this he recorded the whole history of the undertaking, and the results of his tests on the deflections and temperatures of the dams under a wide variety of conditions.

REGENERATED RUBBER.—Objects made of a new regenerated rubber product, called agatit, were shown by Professor M. Le Blanc at the April meeting of the Bunsen Gesellschaft. This product has been worked out in the institute for physical chemistry of the University of Leipzig, by Le Blanc and Lüttke, in conjunction with industrials. It is supplied either in a fine emulsion or colloidal solution, which is convenient for many applications, or as a solid. The latter is much used, it was stated, in packing for condensers and on U-boats. It also serves as a substitute for leather, and is in one respect superior to rubber for this purpose, because it can be nailed and sewn, which is important for sole leather. Rubber gloves for medical men and feeders are also made entirely or largely of agatit. It was mentioned that rubber gloves were hardly obtainable at all in Germany now, whilst these new gloves only cost 2.50 marks; it is doubtful, however, whether this figure meant the estimated cost of manufacture or the sale price.

A 1,000*l.* MOTORING PRIZE.—The offer by the Automobile Association of 1,000*l.* for the best method of using coal gas on motor vehicles has aroused considerable interest. A number of inventions have been definitely entered for the competition, and, in addition, many valuable suggestions by motorists and others interested have been received by the Association. Incidentally, the competition has stimulated research and investigation concerning the possibility of using other fuels besides coal gas, petrol, and petrol substitutes, while the important question of adequate supplies of coal-gas and benzol for post-war motoring requirements has, likewise, received a much-needed impetus. Entries for the competition, also correspondence, have been received from well-known engineers and gas experts, private motorists, members of the motoring industry, and working men and mechanics, many of whom have for some time past been endeavouring to devise practical and inexpensive methods of propelling motor vehicles with coal-gas and other fuels. Entry forms and letters concerning this competition have been received from motorists serving with the Forces in France, Italy, Salonica, and Mesopotamia. Inventions may be entered up to December 31, 1918. Copies of the entry forms and the conditions governing the competition will be sent upon application to the secretary, A.A. & M.U., Fanum House, Whitcomb-street, London, W.C.2.

THE HOWDEN DAM; THE DERWENT VALLEY WATER-WORKS.

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(*For Description, see Page* 687.)

FIG. 6.

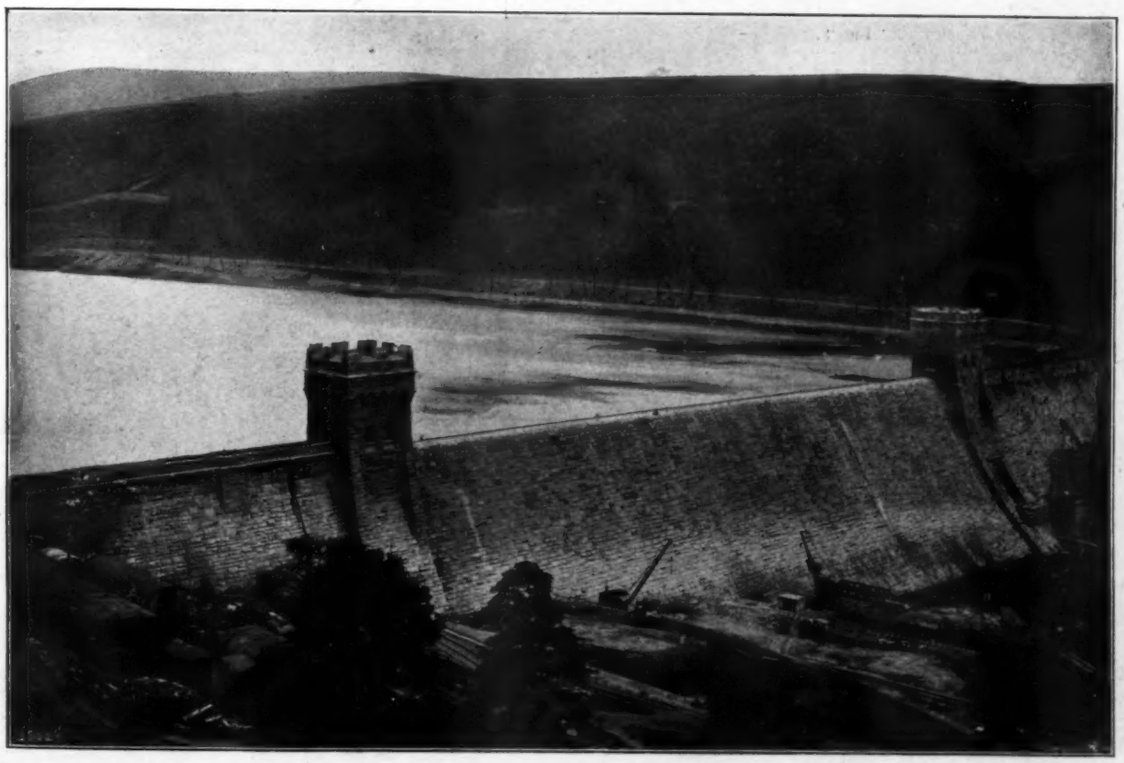

FIG. 7.

(*To face page* 688.)

DAMS IN THE DERWENT VALLEY AND THE GEOLOGICAL FORMATION OF THE SITES.

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(*For Description, see Page* 687.)

FIG. 8.

FIG. 9.

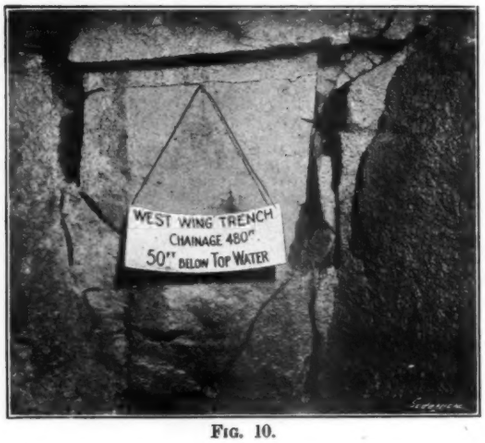

FIG. 10.

FIG. 11.

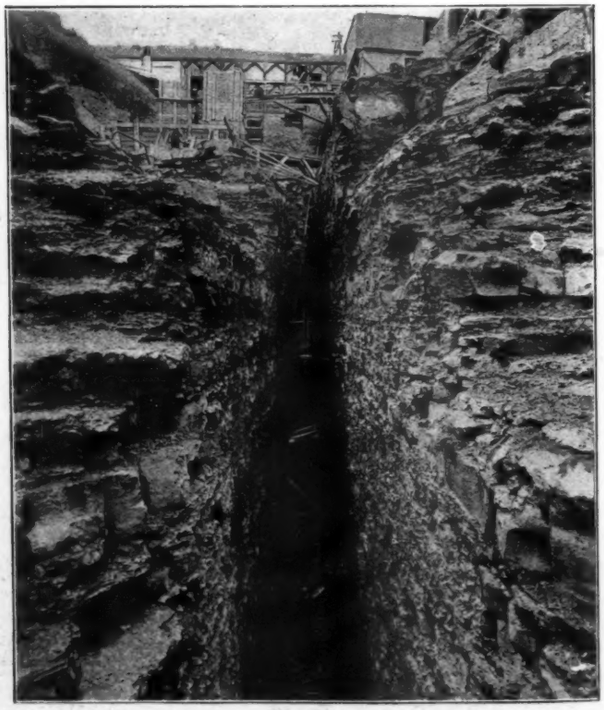

FIG. 12.

THE DERWENT DAM; THE DERWENT VALLEY WATER-WORKS.

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(*For Description, see Page* 687.)

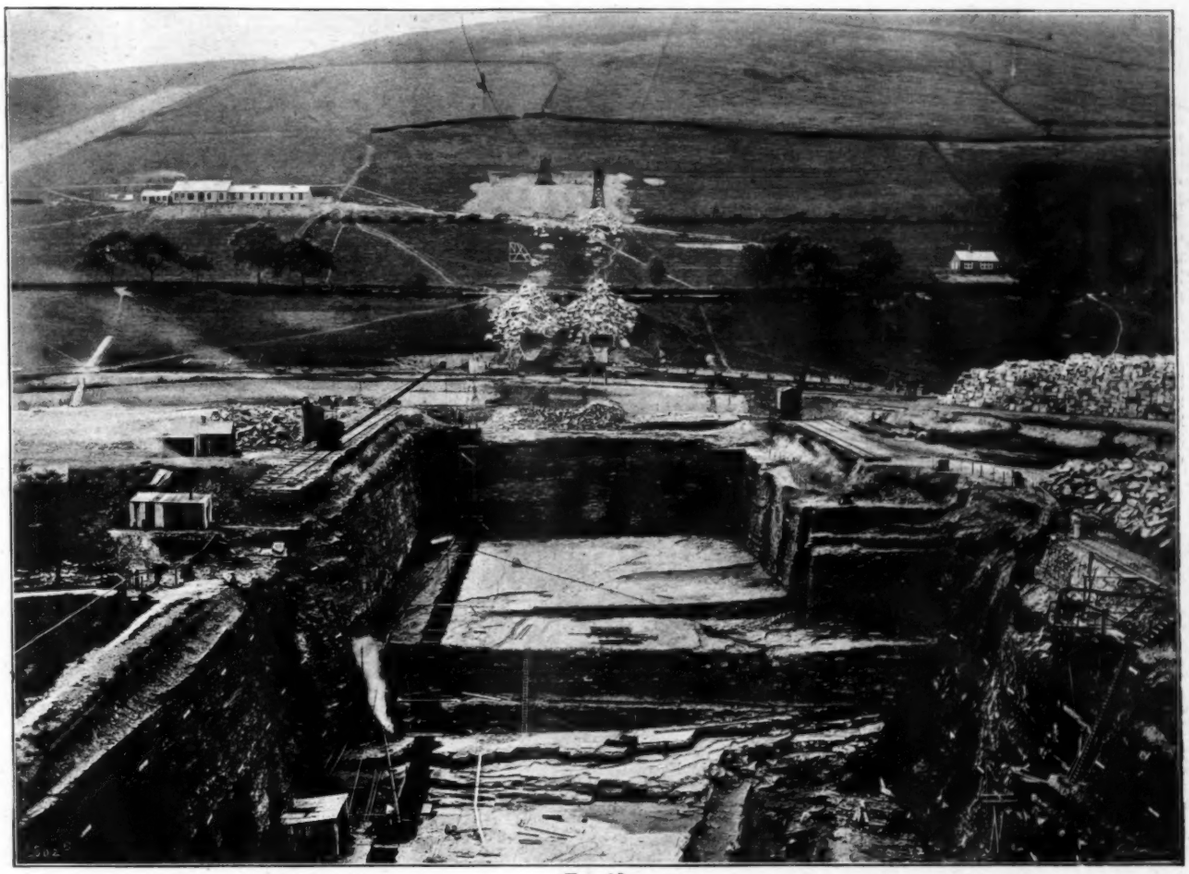


FIG. 13.

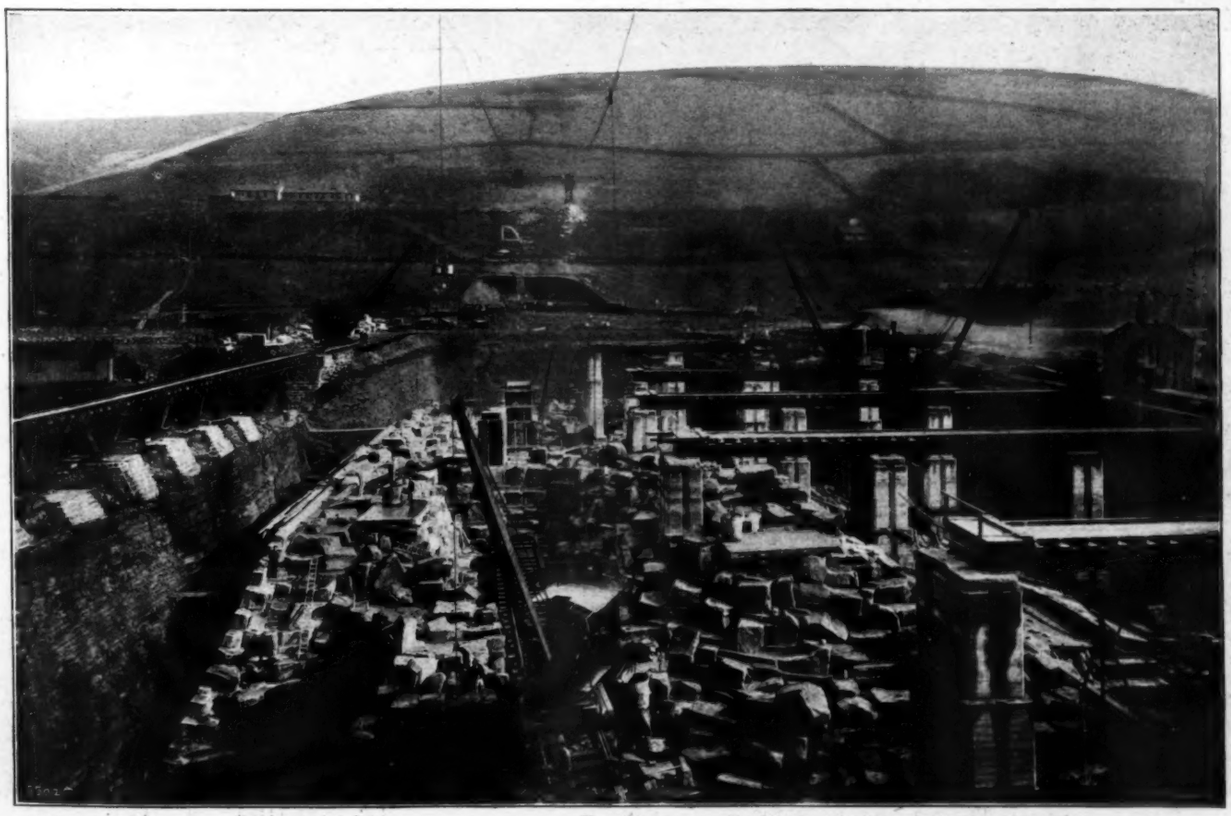


FIG. 14.

THE DERWENT VALLEY WATER-WORKS.

MR. EDWARD SANDEMAN, M.Sc., M.INST.C.E., ENGINEER, LONDON.

(*For Description, see Page* 687.)

FIG. 15. MEASURING WEIR ON THE DERWENT ABOVE BAMFORD VILLAGE.

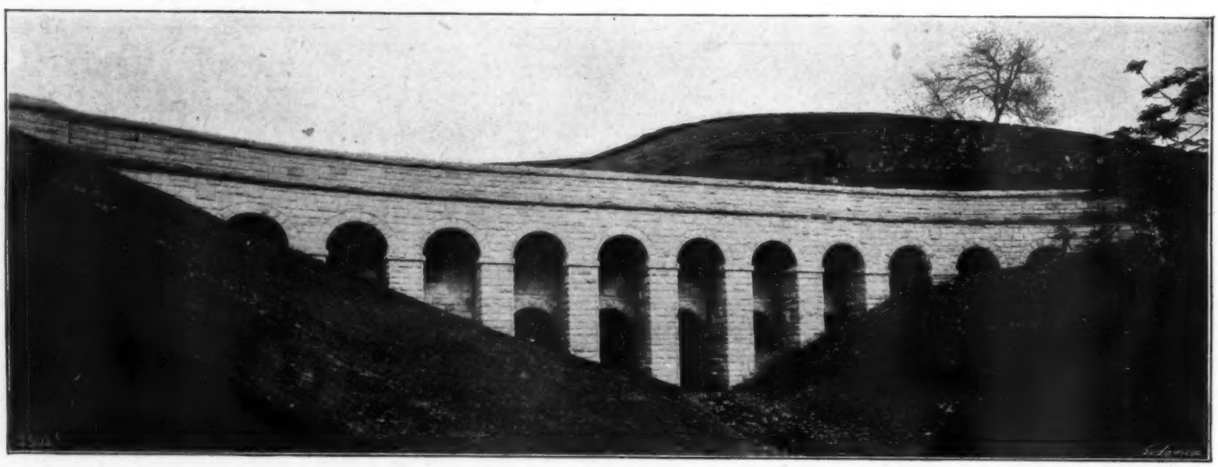


FIG. 16. AQUEDUCT BETWEEN HOWDEN AND DERWENT DAMS.

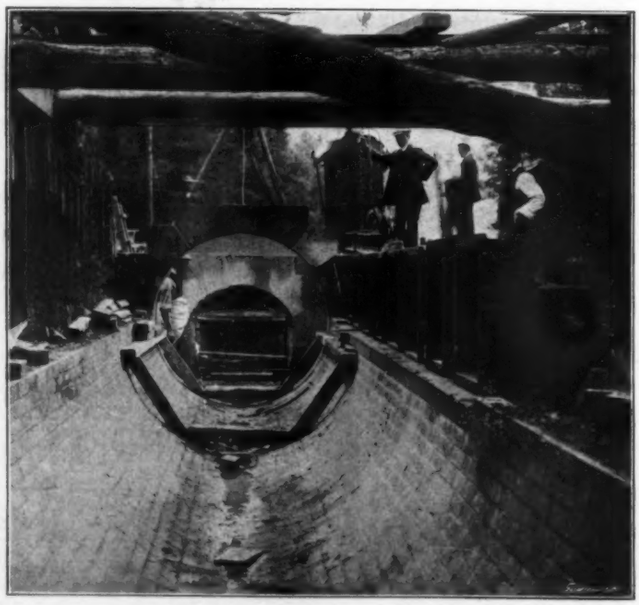


FIG. 17. CUT AND COVER IN AQUEDUCT.

FIG. 18. INCLINE FROM QUARRY.

(*To face page* 689.)

DERWENT VALLEY WATER-WORKS.

MR. EDWARD SANDEMAN, M.Sc., M.INST.C.E., ENGINEER, LONDON.

Fig. 1.

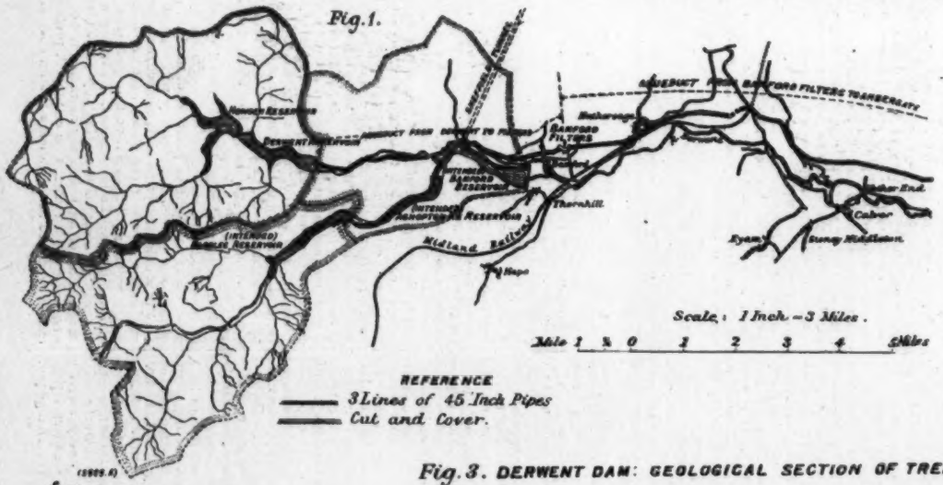


Fig. 2. PLAN OF HOWDEN DAM

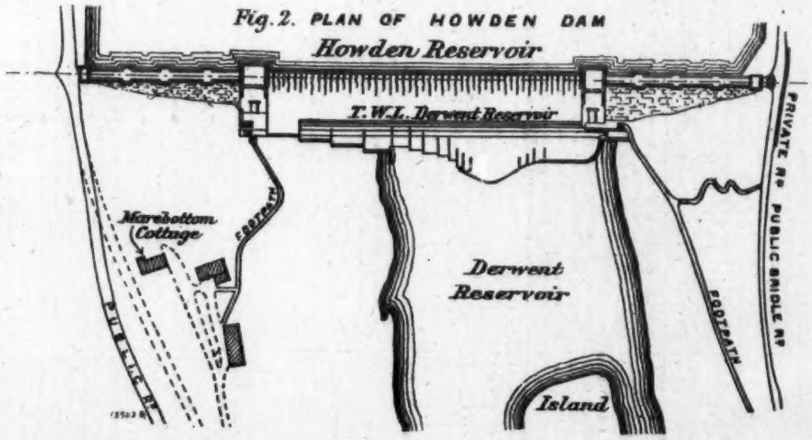


Fig. 3. DERWENT DAM: GEOLOGICAL SECTION OF TRENCH

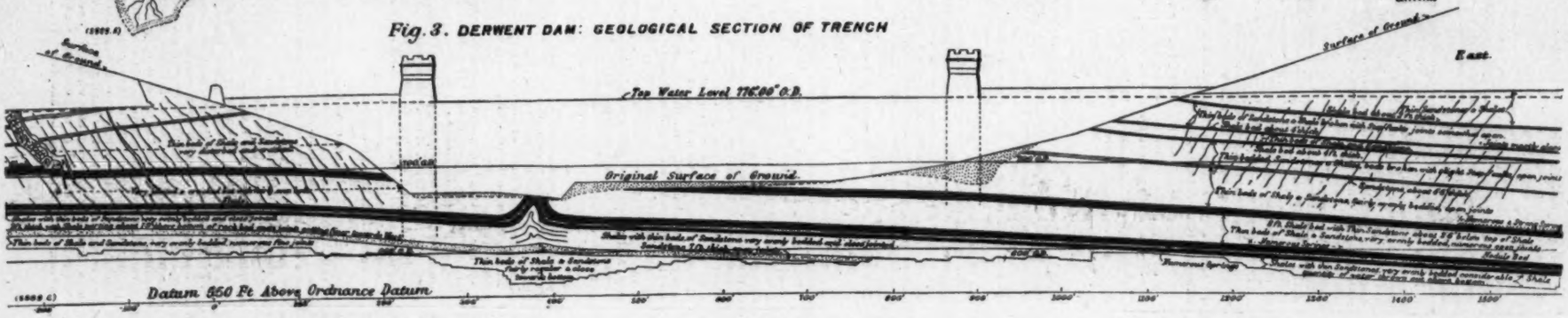


Fig. 4. HOWDEN DAM. GEOLOGICAL SECTION OF TRENCH LOOKING UP STREAM

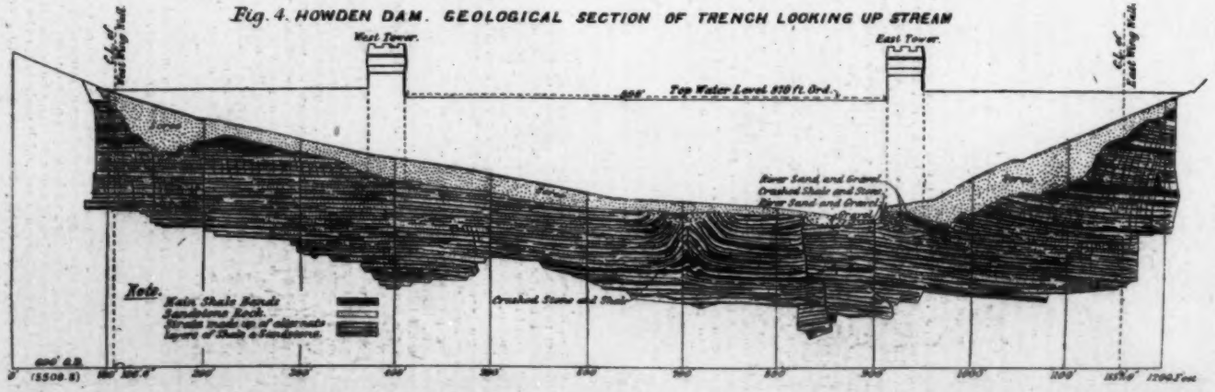
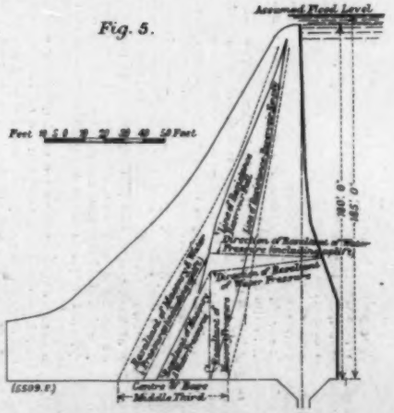


Fig. 5.



STEAM AND POWER PLANT FOR CHEMICAL WORKS.

TO THE EDITOR OF ENGINEERING.

SIR,—The article in your issue of May 17 is of considerable interest to the limited number of engineers whose experience has brought them closely in touch with the operation of chemical works, dye works and high explosives factories. There is not a topic on which there are not a variety of views, and the writer ventures to put forward some alternative opinions to those expressed in the article.

In one paragraph it is stated (in italics), "The consumption of steam per horse-power hour is of no consequence." This is a remarkable and surprising statement, particularly in these days of coal conservation sub-committees, &c., every unit of electricity that can be generated at practically no cost should be generated, therefore it is desirable to keep the steam consumption per horse-power hour at the lowest possible figure. The day of heavy chemical manufacturing is passing, and more accurate and scientific methods are being adopted, which include the development of electro-chemistry, that requires large supplies of power at a low cost.

Let us assume that engines are used receiving steam at an initial pressure and temperature of 240 lbs. per sq. in., 550 deg. F., that they exhaust at a back pressure of 30 lbs. per sq. in., and are driving generators; the steam consumption would be between 40 and 45 lbs. per k.w. hour, and the size of the set would be limited to about 750 k.w. Then, with the best form of oil separator, only about 60 per cent. of the oil in the steam would be removed, the remaining 40 per cent. passing on to the processes.

Now let us consider turbines of, say, 3,000 k.w. size, receiving steam at an initial pressure and temperature of 350 lbs. per sq. in., and 750 deg. F., exhausting at the same back pressure, *i.e.*, 30 lbs. per sq. in. The steam consumption would be from 20 to 22 lbs. per k.w. hour, the steam would be free from oil, and what is rather an important factor, the exhaust steam would still be superheated (to the extent of about 90 deg. F.) which would be valuable, not merely on account of its additional heat-content, but rather as a dryness factor. By properly proportioning the initial pressure and temperature, the requisite degree of superheat in the exhaust can be obtained, which avoids the necessity of passing the exhaust steam through a separately-fired superheater, as suggested in para. 6 of the article where engines are being considered.

The generation of steam at 350 lbs. per sq. in., superheated to 750 deg. F., requires a little additional coal when compared with 240 lbs. per sq. in., and 550 deg. F. (together with the coal used for the separately-fired superheater), but the two-fold increase of power obtained amply justifies a little extra coal. Boilers working at 300 to 350 lbs. per sq. in. have, to the writer's knowledge and experience, already given satisfactory operation for periods up to seven years, and initial temperatures of 750 deg. F. have proved satisfactory on a certain type of turbine for four years, so that there is every reason to take a progressive view of the situation. Engine builders will strain every effort to compete with the turbine, but in general practice they do not care to go beyond a pressure of 240 to 250 lbs. per sq. in. and a temperature of 550 deg. F. Large turbines have every thing to recommend them from the point of view of reliability and freedom from wear, as compared with high-speed reciprocating engines.

The writer's opinion is that from the manufacturer's point of view, as well as in the national interests, the quantity of low-pressure steam required for the processes should be the predominating factor, that quantity of steam should be generated at the highest possible pressure and temperature, and exhausted from the prime movers at a back pressure to the low-pressure heating system for the processes, the greatest amount of energy being obtained in the expansion. If the amount of power required for the works is more than can be generated by the back-pressure system, then, obviously, the additional requirements must be made up from standard high-pressure plant. If, on the other hand, the amount of power available is in excess of what is required for driving purposes, the directors of a really progressive concern, finding themselves with a given amount of power available at practically no cost, will quickly instal some electro-chemical processes, or else dispose of the power available to a neighbour.

Chemical works, &c., also require compressed air and other gases, the compressors only requiring a fraction of the total power capable of being generated by the prime movers. It is advisable that the compressors should be electrically driven from the main generating sets, so that the whole of the steam is used in the most efficient way. If the system is an alternating current one (a point to be discussed later), the motors driving the compressors can be of the synchronous type, having a leading power factor which will assist in correcting the lagging power factor on the generators caused in the usual way by the employment of induction motors. Such motors would be coupled to the compressors through friction clutches, so that power factor correction could be obtained with the motors running light and the compressors shut down.

Of course, the electrical and steam demands cannot be expected to synchronise exactly at all times, and some cushioning or variable arrangement must be provided. The system may consist of one or more plain-back pressure sets, combined with either a pass-out set in which a variable proportion of the steam can be condensed, or a standard high-pressure set which undertakes the regulation, leaving the back-pressure set or sets to give out the maximum energy they can from the steam passing through them.

It is highly desirable that the pressure of the steam supplied to the processes should be kept at the lowest possible figure; some chemical works operate at as high a pressure as 45 to 60 lbs. per sq. in. If the steam is used for heating stills, &c., then, with low-pressure steam of, say, 15 lbs. per sq. in., arrangement has to be made for a somewhat larger volume than at 45 lbs. per sq. in. The vital point is to get the steam to the processes comparatively dry, or with a few degrees of superheat, the heat-content of 15 lbs. pressure steam being very little less than 45 lbs. It can be even higher if the 15 lbs. steam is slightly superheated, whilst the 45 lbs. steam has a fairly high moisture-content. In a well-designed and well-insulated pipe system, it is possible to deliver steam at a pressure of 15 lbs. per sq. in. at the processes with a commencing back pressure of 20 lbs. per sq. in. at the power house, providing the power house is not more than a reasonable distance away, say, half a mile.

Taking an average figure for the steam consumption of the back-pressure turbine previously referred to at 21 lbs. per k.w. hour, with a back pressure of 30 lbs. per sq. in., the consumptions would be:—

19 lbs. per k.w. hour, with a back pressure of 20 lbs.
18 lbs. per k.w. hour, with a back pressure of 15 lbs.
17 lbs. per k.w. hour, with a back pressure of 10 lbs.

the temperatures of such back pressures would be the saturated temperature, plus:—

77 deg. F. superheat for 20 lbs. back pressure.
66 deg. F. superheat for 18 lbs. back pressure.
50 deg. F. superheat for 17 lbs. back pressure.

Where the steam is used for lifting ejectors, or as they are more frequently called, "blow-jacks," the practice has been to use an inefficient form of machine constructed either in earthenware or Regulus (an alloy of lead, antimony and tin, used on account of its acid-resisting ability). But a great deal of work has recently been done with an ejector designed on the lines of the exhaust injector, and constructed in one of the well-known acid-resisting irons. Apart from that, a more efficient type of ejector is now being made, which, with a pressure of 15 lbs. per sq. in., will meet the bulk of the requirements.

The steam demand is not so fluctuating as might be imagined. When a process is re-starting, after having been closed down, it is usually possible to get a little warning and be prepared, but apart from that with a modern plant of water-tube boilers, mechanical stokers and induced or pressure draught, it is possible to cope with the situation very quickly and more satisfactorily than with a bank of Lancashire boilers, as the latter do not admit of forcing for a short time in the same way as water-tube boilers, and it is, therefore, even more necessary to keep an excess number of Lancashires in operation, as your article suggests, for water tubes.

Most chemical works are situated on the banks of a canal or river, and both the water of the canal or river and the atmosphere of the works are in a doubtful and corrosive condition, in spite of all efforts that are made to prevent it. In operating high-pressure sets requiring condensers, under no condition should canal water be relied upon, but rather cooling towers or ponds, and even with those, the cooling water should be fairly frequently changed on account of the acid vapour, &c., likely to be absorbed from the atmosphere. It is even worth while considering protecting the condenser tubes by some form of electrolytic process. The contamination of the air has serious effect on air compressors, switch-gear, and generators, either alternating current or direct current; good practice is to provide for the whole of the air entering the power station engine room to pass through a general filter and washer, built as far as possible of glazed brick and cast-iron, then, through an independent filter for each generating set, the warm air finally being removed from the engine room and used for the boiler furnaces, as it has a double value having been warmed slightly and also freed of corrosive impurities.

In the whole of the foregoing the pressures are gauge pressure, and not absolute.

On the electrical side, one is almost disappointed to find low-pressure direct current recommended in preference to medium-pressure alternating current. All bare metal, particularly copper and brass, that is not absolutely imperative, should be avoided. This applies equally to generating plant, switch gear and motors. Alternators will certainly prove much more satisfactory than direct-current generators and squirrel-cage motors, if properly installed, give much more satisfactory results than any form of direct-current machines. Under no condition should a plain open type machine be installed, though, unfortunately, that has been the practice in the past. The ordinary pipe-ventilated machine is a snare and a delusion, and the totally-enclosed machine is both bulky and extremely expensive. There are two types worthy of consideration, viz., the pipe-ventilated machine, in which the suction and delivery ducts are coupled together through a form of surface cooler, and the totally-enclosed externally-cooled machine, which has a double frame with an annular space between the two frames. The inner frame totally encloses the motor and air is blown through between the two frames by a fan fixed on the motor shaft, so giving a cooling effect. The weight of metal employed is about the same as in an open-type machine, whilst price is only a little higher. If variable speed is imperative, and cannot be obtained in any other way, then a change-pole squirrel-cage machine, or an alternating-current commutator machine, can be employed, the latter having all the charcteristics of a direct-current machine, whilst, if heavy starting torque is required with or without some speed variation, the cascade machine can be adopted. The change pole squirrel-cage machine would only require an extra number of terminals, but would not have any bare parts such as commutator, brush gear or slip rings. Similarly, the single-speed Cascade, whilst the two or three-speed Cascade would have slip rings, and the alternating-current commutator motor would have bare metal, and be practically the same as a direct-current machine, which it is highly desirable to avoid. The effect of speed variation can, however, in 90 per cent. of the cases, be achieved by other means almost as efficient. For instance, one of the principal drives in a chemical works is that of fans, and ample and reasonably efficient regulation of these can be obtained by means of dampers. For variable speed, combined with heavy-starting torque, the ordinary squirrel-cage motor can be employed in conjunction with the oil hydraulic transmission system. One is not inclined to readily accept the statement that a direct-current motor is superior to a squirrel-cage alternating-current machine for its "large safe overload capacity and simple starting gear." In numerous instances, it has been advisable to instal a squirrel-cage motor slightly larger than was really necessary for ordinary running in order to accomplish the starting effort required, rather than to instal slip-ring machines embodying bare rings, brush gear, &c. Expediency and reliability frequently carry more weight than pure engineering, and it is expedient in the interest of reliability to avoid all bare metal which no matter how well enclosed, is liable to attack. It is questionable at the present time if there is a really satisfactory acid pump on the market; no doubt, the future will see something suitable developed which it is expected will be on the lines of a vertical spindle centrifugal pump, and such being the case, there will be a demand for a line of small vertical spindle motors.

On the subject of switchgear, totally-enclosed gas-proof apparatus can be employed, but very satisfactory results are obtained with standard oil immersed gear in cast-iron cases, of which there are now several types on the market. Every starting panel should embody an ammeter calibrated in horse power, as well as in amperes, to the characteristic curve of the motor, so that even the least informed process hand can read in horse power something that he would not understand in amperes.

Considerable progress has been made with the development of insulating materials and varnishes of an acid-resisting nature, and the future will, no doubt, see the day when a thoroughly sound material will be available. It should be, and is, possible to instal machines, even under the worst conditions, so that they do not constitute a danger to the operators. If they are properly earthed and the earth maintained efficient, and also wires and cables of a really suitable kind employed and duly maintained, the risk of the operators receiving a fatal shock is very slight. Accessories for lighting can be employed which are reasonably safe and resist attack; they include such articles as wood blocks, impregnated with paraffin wax, totally-enclosed tumbler switches, having fibre covers and dollies outlasting from six to ten ordinary tumbler switches, porcelain lamp holders filled on the leading-in side with paraffin wax, and having a rubber sealing cap over the mouth through which the lamp is inserted. In very corrosive processes, it is advisable to abandon the use of ordinary ceiling roses, and either loop right into the lamp-holders or connect the flexibles direct on to the main leads, or employ a form of oil or compound sealed ceiling-rose fitting. Conduit should not be employed, as it is extremely liable to corrosion itself, and also assists the condensation of corrosive vapour inside, which speedily attacks the insulation of the wires contained.

All wiring of a smaller class should be erected on porcelain cleats, screws supporting the cleats first being dipped in a good quality anti-sulphuric paint, and, after fixing, brushed over with the paint. A special form of acid-resisting cab-tyre sheathed wire is available, and also an ebonite-finished wire, but the latter has to be put in position whilst tolerably warm, as the outer casing has a tendency to crack if bent cold. The life of all such wiring can be considerably increased by periodically wiping it over to remove all foreign material, and then painting with anti-sulphuric enamel, or a form of bitumen paint, according to its location, *i.e.*, bitumen is satisfactory for acid, but liable to attack by caustic or alkali. A form of asbestos braided wire is fairly satisfactory, but the asbestos braid should preferably be carefully impregnated with a bitumastic solution, otherwise it tends to absorb corrosive liquids, and whilst not suffering damage itself, it enables corrosion to set in on the insulation underneath. For main cables, both from a commercial and engineering point of view, the paper insulated lead-covered cable, with an outer sheathing of some form of bitumastic or other acid-resisting fabric, still holds its own. For protection of lighting and power circuits, oil immersed circuit breakers are unquestionably the best. If fuses have to be employed, on no account should bare iron or copper be used, owing to its rapid deterioration, consequent upon oxidation and corrosion, especially when hot, and in a corrosive atmosphere. For bare fuses bimetal, which is practically a core of copper surrounded by a Regulus sheath, gives much the best result, or as an alternative cartridge fuses, with or without oil immersion, are very good.

Great attention must be paid to all meters, whether of the indicating, recording or integrating type. Cases must be as gas-tight as possible, even then, in the case of mercury meters, the mercury will tend to "sicken." Shunts should always be oil-immersed, as when corrosion sets in the leaves of the shunt become corroded away, giving an unduly high milli-volt drop, and an inaccurate high reading on the instrument. In taking a reading of the load on a motor operating any particular plant, an observation of an indicating ammeter is not sufficient; a recorder should always be employed, preferably for at least a week, so as to indicate the number of stops and

re-starts (usually very few), and also the characteristic variations of the load.

On the general principles of direct current, as compared with alternating current, direct current cannot be generated as efficiently as alternating current, and, therefore, in these days of high-efficiency rotary converters, no very strong argument can be advanced for the use of direct current generally, merely on account of its necessity for electrolytic work. If possible, the electrolytic plants requiring heavy current should be installed near to the power house, so as to avoid long runs of heavy cable, with its inherent expense and volt drop. The rotary converters could then be installed in the power house, where they would be subject to the minimum amount of attack and corrosion. If the electrolytic plants should be a distance away from the power house, then, preferably, the rotary converters should be installed immediately adjacent in a self-contained sub-station, so as to be protected against corrosion, and they should, as far as possible, be automatically operated from the power station, but supplied from the works ordinary mains system. Such rotary converters should also embody some degree of power factor correction; if installed in the power station, they will correct for the generating plant only, but if installed in distant sub-stations, they will benefit the mains system also.

Transformers should preferably be of the totally-enclosed type, having a considerably greater oil capacity than obtains in standard practice. If so enclosed, ventilation may be resorted to, or a water-cooled oil system may be adopted. An important point is to effect the cooling of the oil without allowing it to come in contact with the corrosive atmosphere, from which it may, in time, absorb matter dangerous to the windings.

In laying out the supply of the commodities, such as steam, electricity, air, water, &c., provision should be made for the accurate measurement of each commodity to each process, so as to assist costing.

"DUM SPIRO SPERO."

"DUMPING."

TO THE EDITOR OF ENGINEERING.

SIR,—In a previous letter I pointed out that most countries were the fortunate possessors of something that England lacked; and I asked a simple question. Instead of answering it, "Timeo" dubs me a Cobdenite, and he mentions several war-time expedients to which we have been driven because of our want of foresight and skill—"dumping!" being, by implication, blamed for the results.

As "reprisals" are now the common order of the day, let us, after the war, dump Welsh coal into Germany, and so close her collieries; let us flood that country with cheap Burton ales, in order to ruin Munich and other brewers; let us export young English brains under cost price, as a set-off against cheap German clerks, who come here and become millionaires; and let us compel Germany to ruin herself by adopting Free Trade. Above all, let us say, "Look a gift-horse in the mouth," instead of dumping a Latin quotation about the Greeks!

Sir, in face of the natural advantages of other countries, I beg you to allow me again to ask seriously "*who* is to pay for protecting our industries?"

Your obedient Servant,

June 15, 1918. "ONE WHO DOESN'T KNOW."

THE DEFINITION OF HARDNESS.

TO THE EDITOR OF ENGINEERING.

SIR,—I think your correspondent, Mr. Buckingham, has not read my memorandum on the definition of hardness (ENGINEERING, May 17) with sufficient care, or he would have seen that I was quite aware of the difference of Martel's D and Brinell's H, "in cases representative of the practical limits of the Brinell test." Further, in dealing with the Brinell test, I excluded the case of deep indentations. The case Mr. Buckingham calculates, of an indentation one-fifth in depth of the radius of the ball, is, in my view, a deep indentation. Using my equations and the quantity k, which, so far as I am aware, has not previously been mentioned in connection with hardness, Mr. Buckingham finds that H and D differ by the quantity $k\,h/2\,r$. If there is no approximation either for D or H, then the difference is $k\,h/6\,r$, which in my view is negligible. I was dealing only with the definition of hardness, and for simplicity avoided reference to secondary causes of difference.

Nevertheless, that H = D when the indentation is small is significant. Brinell defined the hardness number as—

$$H = \frac{P}{2\pi r\{r - \sqrt{(r^2 - a^2)}\}}$$

where r is the radius of the ball, and a that of the indentation. I am now convinced that he would have been better inspired if he had taken the simpler expression—

$$H = \frac{P}{\pi a^2} = k$$

In that case, H = D = k, as far as analysis goes, without restriction to small indentations. No explanation of Brinell's expression has been given, and it seems inconsistent with plastic deformation. If the latter value had been taken, the hardness scale would probably have been a more rational one.

In practical testing there would still be a difference between H and D, due to various causes, of which probably the chief is the time effect. In the Martel test, the pressure acts for a very short time. In the Brinell test, it is prescribed that it should be continued, for at least two minutes in the case of a very hard material, and five minutes in the case of a ductile material. Then the volume of an indentation may be expected to be greater, and the hardness number less than in a Martel test. Now Guillery has shown that in Brinell tests, the hardness number deduced from a test in two seconds is 8 per cent. to 14½ per cent. greater than in one made slowly.

For practical purposes, an empirical and merely relative test of hardness may be quite useful and convenient. Such a test is the scratch test, and also, I think, the much-used scleroscope test. But until a rational definition of hardness is found, there is no basis for criticism of different methods of determining hardness. So far as I can see, the Martel and Brinell methods are the most rational now used for ductile material. It is not clear that they are applicable to brittle materials. Apart from practical convenience, there is some reason for thinking that Martel's method is slightly the more rational of the two.

W. C. UNWIN.

THE STABILITY OF AEROPLANES.

TO THE EDITOR OF ENGINEERING.

SIR,—We are unwilling to intrude further on your kindness, but we are glad to note that Mr. Webb at last admits that our criticisms of his proof are just. The error in wording which he has discovered in his own article, let it be clearly understood, does not affect our argument, although in his last letter he states quite illogically "with this correction, I believe the proof is sound." We can only conclude that Mr. Webb still misses the point which is clear to all his readers.

The sum and substance of the position is that after all Mr. Webb has actually, in ignorance, been expounding and misapplying the principle of moving axes, although he claimed otherwise, and that, therefore, his treatment, where it is sound, is not new, and where it is new, is not sound. Even the artifice of choosing axes so that $p = \phi$, $q = \theta$, and $r = \psi$, has already appeared in published work on aeroplane stability since 1914 at least. In conclusion, it is clear that any attempt at a proof, however bad, is not good enough for an engineer.

Yours faithfully,

W. L. COWLEY.
H. LEVY.

The National Physical Laboratory, Teddington, Middlesex, June 17, 1918.

THE GERMAN DYE INDUSTRY.

CONSIDERING the scope of the German dye and kindred industries and the large capital invested in these undertakings, special interest is attached to their reports and balance-sheets. Last year showed increasing profits, varying somewhat for the different works. But owing to the large increase in the share capitals entitled to participate in the dividend this has in most cases fallen a little below the figures of 1916. The Friedrich Bayer concern of Leverkusen, whose capital in December, 1917, was increased from 54,000,000 to 90,000,000 marks (at the exchange of 107 per cent.), and which new shares, though not paid for, have received the full dividend for 1917, boasts net profits amounting to 28,127,201 marks against 21,396,823 marks for 1916, 15,541,148 marks for 1915, 13,532,380 marks for 1914, and 15,293,283 marks for 1913. Writings-off amount to 11,852,090 marks, about the same as the two previous years; 5,000,000 marks are added to the reserves, 2,000,000 marks to the war invalid fund, and for the first time 1,000,000 marks have been applied to "on leave wages." The war profit tax has been deducted prior to the gross profits being made up. The dividend was again fixed at 20 per cent.; but whilst there was for 1916 an extra bonus of 8 per cent., no such additional dividend was declared for 1917. On account of the increased capital the dividend amounted to 18,000,000 marks against 15,120,000 marks for 1916 for dividend and bonus. Credit at banks, cash and bills of exchange, amount to 97,120,000 marks against 77,640,000 marks for the previous year, but it has caused some surprise that no holdings of bonds and stocks are specified as the firm is known to have subscribed handsomely to the war loan. The figures at which land and buildings stand booked have receded from 31,100,000 marks to 24,120,000 marks, and those of plant, &c., from 13,640,000 marks to 3,170,000 marks; and as extensive additions for war purposes have been made and at least to a material extent written off, the actual writings-off must considerably exceed the figures under this head in the balance-sheet. Shares in other undertakings have increased from 16,970,000 marks to 18,440,000 marks. Reserves now amount to 38,730,000 marks. The new shares appear in the balance-sheet on the credit side as claims on shareholders for 36,730,000 marks, although they have received dividend, and the share capital figures for 90,000,000 marks. The Fried. Bayer Company has the same share or quota in the joint concern as have the Höchst and the Ludwigshafen (The Baden Aniline Works), viz., 24·82 per cent.

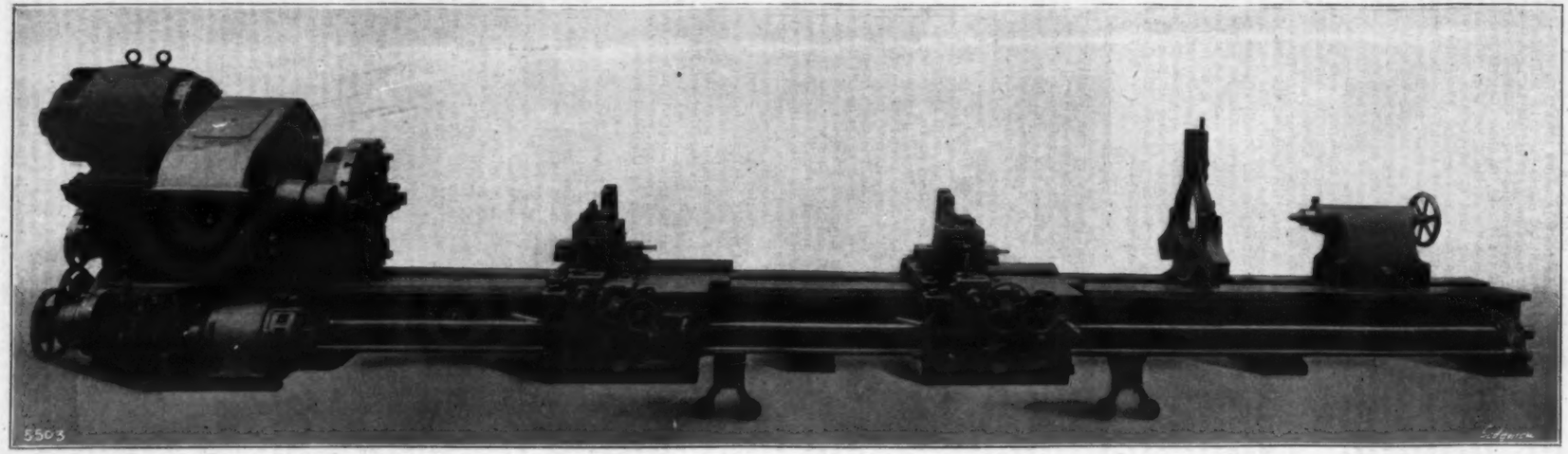
The Höchst Works (formerly Meister, Lucius and Brüning) have likewise, during the past year, increased their capital from 54,000,000 marks to 90,000,000 marks, also at the exchange of 107 per cent.; and the new shares have also received full dividend for 1917, although the net capital has not benefited the company in the year in question. Whilst the gross profits show a very substantial increase as compared with the previous year, namely, 51,205,956 marks for 1917, against 38,709,152 marks for 1916, 26,740,592 marks for 1915, 19,089,447 marks for 1914, and 21,869,170 marks for 1913, the net profits remain about the same as for 1916, the figures being respectively 22,516,228 marks and 22,049,678 marks, against 13,919,735 marks for 1915, 10,870,511 marks for 1914 and 14,655,856 marks for 1913. Writings-off have increased from 11,014,388 marks for 1916, and 4,450,643 for 1913 to the large sum of 19,161,303 marks for 1917, workmen's housings for 1917 figure for 3,123,936 marks, against 773,158 marks for the previous year; welfare arrangements for 1,040,174 marks, against 661,293 marks for 1916. Although the dividend has been reduced from 25 per cent. for 1916 to 18 per cent. for 1917, it absorbs 16,200,000 marks against 13,500,000 marks for the preceding year. For the two last peace years the dividend was 30 per cent., and 20 per cent. for 1914 and 1915. Although the company has again sold the shares acquired during the previous year in the Elise II Gewerkschaft to the Baden Aniline and Soda Company at cost price, the holdings of bonds and stocks have risen from 36,700,000 marks to 45,480,000 marks, the company having subscribed 8,000,000 marks both to the seventh and the eighth war loan. The original aggregate cost of all buildings, plant, installations, &c., is stated to be 141,180,000 marks, against 117,550,000 marks for the previous year, but owing to the extensive writings off the booked value has only risen from 26,030,000 marks to 30,510,000 marks. Credit at banks, cash and bills of exchange, amounted to 42,050,000 marks at the end of 1917, against 16,510,000 marks a year previously. The company's reserves amount to 35,170,000 marks. The report points out that the proposed corn brandy taxation gives cause for serious apprehension, inasmuch as it theatens a valuable process adopted by the company during the war for production of acetic acid and alcohol from calcium carbide.

BLIND PEOPLE IN THE ELECTRICAL INDUSTRIES.—Sir Arthur Pearson, who, as is well known, is doing a vast amount of most valuable work in the interest of our blinded soldiers, has stated in *St. Dunstan's Review*, that there is a promising new occupation for blind people, namely, the winding of coils for the armatures of electric machines. He read an account of this work in an American scientific journal, and at once communicated with an old friend of his, Mr. Hugo Hirst, the director of the General Electric Company. Mr. Hirst took the matter up with characteristic kindness and energy. He cabled to Dr. Wheeler, with whom he is well acquainted, for full particulars, and as the result, Dr. Wheeler came over from America to supervise the starting of this new industry for blind people. Dr. Wheeler paid a visit to St. Dunstan's, then Mr. Hirst called a meeting of the heads of the largest electrical firms in the United Kingdom, when the matter was very fully discussed, and Sir Arthur was able to demonstrate to the experts present the ability of a blind person to accomplish the desired results. Sir Arthur suggested to the meeting that he should place himself in communication with Mr. W. H. Thurman, superintendent of the Birmingham Royal Institution for the Blind, and suggest to him that he should instal the industry on an experimental basis in his workshops, obtaining the necessary material from the Birmingham works of the General Electric Company. To this Mr. Hirst and Mr. Thurman readily and generously agreed. Sir Arthur has not the least doubt that the experiment will prove a complete success, and that it will open up a new and very valuable channel of employment for the blind worker.

OZONE IN THE LOWER ATMOSPHERE.—Assuming that the limitation of the solar spectrum in the ultraviolet, where the spectrum ends at $\lambda = 2{,}948$ in observations made at sea level, is due to the absorption of the sun rays by the ozone present in the upper atmosphere, the Hon. R. J. Strutt has recently made experiments on the transparency of the lower atmosphere to ultra-violet rays, from which he concludes that the air near the earth's surface is poor in ozone. The experiments (Proceedings Royal Society, April 2, 1918, pages 260 to 268) were made in Essex with the aid of two lamps, a quartz mercury-vapour lamp which admitted of taking observations at a distance of four miles (6·45 km.), and a cadmium-spark lamp, which required adjustment during the long hours of an experiment, so that the maximum distance in this case was only 1,100 m. The spectra were photographed with the aid of a portable prismatic camera, fitted with quartz prism and lens. The comparison data concerning the equivalent layers of air at normal temperature and pressure were taken from the observations made by others on the Peak of Teneriffe at an altitude of 12,200 ft. Professor Strutt does not agree with Cornu's interpretation of those data, however. The main absorption of ultra-violet rays by ozone takes place near λ 2,536. In the case of the cadmium spark, the line 2,313 remained visible on the plates obtained in Essex; the mercury spectrum extended as far as λ 2,536, whilst the limit of the solar spectrum, viewed through the upper air, on the ultraviolet side, is λ 2,948. Thus, it would appear that there can only be little ozone in the atmosphere near the ground. The results would, however, be influenced by scattering of the rays in the air. Hence Professor Strutt conducted other comparative experiments, taking photographs of the spectra through known thicknesses of layers of ozone in tubes. He concludes that the spectral weakening he observed at four miles' distance would be produced if these four miles of air contained 0·27 mm. of pure ozone, and that, on the other hand, an equivalent of 0·26 mm. of ozone would probably be due to scattering. In any case, the pure ozone contents, in the air close to the ground, would not exceed a thickness of 0·27 mm. reduced to normal pressure and temperature.

21-IN. CENTRE SLIDING, SURFACING, SCREW-CUTTING AND TAPER TURNING LATHE FOR GUN WORK.

CONSTRUCTED BY MESSRS. JOHN HETHERINGTON AND SONS, LIMITED, ENGINEERS, MANCHESTER.



On this page we illustrate a 21-in. centre-sliding, surfacing, screw-cutting and taper-turning lathe for gun work, constructed by Messrs. John Hetherington and Sons, Limited, Manchester. The fast headstock is fitted with a self-contained and direct-connected motor, arranged to work through double, treble and quadruple gearing, the final ratio being obtained through a pinion meshing with a spur ring on the face-plate. The whole of the gearing is of steel, with machine-cut teeth. The spindle is a solid hard-steel forging, revolving in adjustable parallel gunmetal bearings, and ball-thrust washers are fitted for taking the end thrust. The faceplate is fitted with four adjustable dog slides. The motor is of 30 to 35 h.p., of the variable-speed type, with a range of speeds from 270 to 1,080 r.p.m.

The movable headstock is securely fixed to the bed by two turned steel bolts, and is fitted with a hard-steel sliding spindle and a set-over saddle. The guiding edges of the bed are square.

The feed motions are obtained through the gear box mounted at the fast headstock end of the bed, and four changes are available for both sliding and surfacing, giving 32, 16, 8 and 4 revs. per inch traverse. The changes are made by the movements of the two levers shown, and the whole of the gearing and clutches are of steel.

The screw-cutting motion is driven from the end of the spindle through the usual reversing motion and change wheels. The guide screw is well supported at frequent intervals, and a long gunmetal half-nut is fitted in the apron of each carriage, and can be engaged and disengaged at will.

There are two carriages, each having a long bearing on the bed and each fitted with an apron at the front, carrying all the various gears for engaging the feed, &c., motions. The whole of the gearing in the apron is of steel, and each shaft has a double bearing. All the operating handles and levers are suitably interlocked to obviate the possibility of engaging any two conflicting motions at the same time, and to safeguard the feed motions when the taper-turning arrangement is in use. All the feed motions can be reversed by the movement of a handle on the apron operating a double-bevel pinion. The slide rests are of rigid design, with full-indexed swivel; compound slides are fitted above the swivel, and the top slides are of steel.

The taper-turning motion is fitted to each carriage independently, and each apron carries swing frame and change wheels, &c., for coupling the motion between the sliding and surfacing feeds. A full set of steel change-wheels is supplied for each carriage, giving tapers from 1 in 2 to 1 in 324, with an almost unlimited number of variations. A rapid-traverse motion is fitted for running the carriages and loose headstock along the bed in either direction, and this is driven by a separate motor shown on the floor in front of the fast headstock. The motor is of 5-h.p. running at 500 r.p.m., giving a rapid traverse of about 9 ft. per minute.

The control gear for both motors is of the semi-automatic type, with push button boxes on each carriage, giving "stop," "start" and "inch" movements for the main motor, and "stop" and "start" only for the auxiliary motor.

The accessories include two centre stays to admit up to 18 in. diameter, and each fitted with three adjustable steel jaws with gunmetal tips; removable back stays with sliding and screw-cutting jaws; water pots and stands; full set of cut change wheels for screw cutting; two sets of cut-steel change wheels for taper turning.

The principal dimensions of the lathe are as follow:—

Height of centres	21 in.
Spindle front neck, diameter and length	7 in. by 10½ in.
Gear ratios, approximate ...	3 to 192 r.p.m.
Movable headstock spindle, diameter	5½ in.
Bed, length, width and depth ...	35 ft. 8 in. by 2 ft. 8 in. by 1 ft. 6 in.
Length between centres... ...	26 ft.
Diameter admitted over carriage	32 in.
Floor space required, approximate	37 ft. 8 in. by 8 ft.
Approximate weight complete with electrical equipment ...	27 tons.

A CAUSE OF FAILURE IN BOILER PLATES.*

By Walter Rosenhain, D.Sc., F.R.S., and D. Hanson, M.Sc. (from the National Physical Laboratory).

The occasional cases of failures in boiler plates met with in practice have formed the subject of several papers and discussions before the Iron and Steel Institute in recent years.† A number of such cases have been investigated by the authors, and it seems desirable to present an account of one which offers features of particular importance which do not appear to have been previously noticed. These features are of special importance, because it may be found that they afford a clue to the cause of failure in other cases, particularly in boiler plates of the largest dimensions.

The failure in question occurred in the last stage of the manufacture of the plate. The size and dimensions of the plate are illustrated in the diagram, Fig. 1. The plate has a thickness of 1⅛ in. and measures 4 ft. 4 in. in width by 11 ft in length. It was manufactured under a stringent specification, but cracked during the straightening of the edges after the bending operations had been completed. Inquiry showed that the bending operations had been carried out in stages in the cold, the plate being subjected to intermediate annealings between the various stages. The position of the crack which formed in the plate is indicated in the diagram, Fig. 1.

The material of the plate was first submitted to chemical analysis, mechanical tests, and general microscopic examination. The results obtained were as follow:—

Chemical Analysis.

	Per Cent.
Carbon	0·16
Silicon	0·079
Sulphur...	0·030
Phosphorus	0·048
Manganese	0·623
Nickel	0·10
Chromium	Nil.

It will be seen that there is nothing abnormal in this composition, which in fact represents a mild steel of high quality.

Tensile tests were taken from the outside and inside of the plate as received, and gave the results in the following table, columns 1 and 2:—

Table I.

Particulars.	Plate as Received.		Plate Annealed. 550 deg. C.	Plate Normalised 900 deg. C
	(Outside.)	(Inside.)	(Outside.)	(Outside.)
	1	2	3	4
Diameter in.	0.375	0.375	0.375	0.375
Cross-sectional area sq. in.	0.1105	0.1105	0.1105	0.1105
Elastic limit tons per sq. in.	14.2	11.3	15.4	18.3
Yield stress tons per sq. in.	18.3	16.1	18.7	19.15
Ultimate stress tons per sq. in.	26.88	27.24	27.61	27.94
Modulus lb. per sq. in.	29.8×10^6	29.8×10^6	30.4×10^6	30.2×10^6
Extension per cent. on 1.3 in.*	31.6	33.1	34.5	42.2
Reduction of area per cent...	59.6	60.7	59.1	62.5

* A gauge length of 1.3 in. is chosen to give a ratio of gauge length to diameter equal to 3.5.

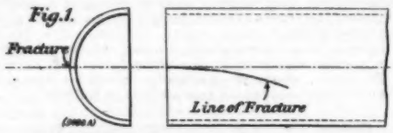
Here again there is nothing abnormal, except perhaps

* Paper read before the Iron and Steel Institute, Monday, May 3, 1918.

† Houghton, *Journal of the Iron and Steel Institute*, 1914, No. I, p. 266. Wolff, *ibid.*, 1917, No. II, p. 137.

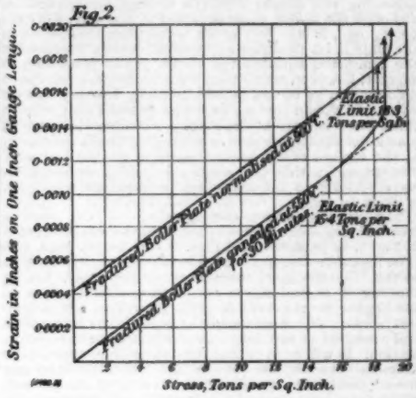
a slight indication of an unusual condition of the steel in the comparatively large difference between elastic limit and yield stress. It was thought that possibly this peculiarity might arise from the existence of internal stresses in the material, and in order to remove these as far as possible without changing the structural condition of the steel, a portion of the plate was annealed at 550 deg. C. for 30 min. The results of tensile tests of a plate in this condition are given in the third column of Table I. It will be seen that the difference between elastic limit and yield stress is still comparatively large. In order, further, to test this point, and also to ascertain how far the tensile tests obtained on the material as received and after annealing at 550 deg. C. correspond to the best properties which the material is capable of attaining, a sample of the plate was normalised by heating to 900 deg. C. followed by cooling in air. The results of tensile tests made on the sample thus treated are given in column 4 of Table I. Here it will be seen that the elastic limit has come very much closer to the yield stress, while the yield stress itself has been raised. The ultimate stress has only been slightly affected, but, on the other hand, the elongation has been markedly improved. The difference between the plate after annealing at 550 deg. C. and after normalising is further illustrated in the curves of Fig. 2, which represent extensometer stress-strain diagrams of two test-pieces so treated. It will be seen that the lower curve shows a gradual departure from elastic behaviour before yielding occurs, whereas, in the normalised material, the elastic behaviour is maintained practically up to the yield stress.

Fig. 1.



Since the tensile tests showed little or no departure from the normal in the material of this plate, it became desirable to apply other tests in order to ascertain whether the properties of the steel were really as satisfactory as the tensile tests would indicate. For this purpose an impact test has been used, for although it is recognised that the conditions under which failure occurs in boiler plate possess no apparent resemblance to those of an impact test, yet experience has repeatedly shown that materials which give a low figure under an impact test are liable to fail under apparently static conditions. The form of impact test employed is that known as the International notched Bar Impact Test, made with a modification of the Charpy impact testing machine, and on specimens measuring 10 mm. by 10 mm. in section by 53·5 mm. in length, having in the middle a rounded notch with a radius of two-thirds of a mm. On the material as received this test gave a mean figure of 0·75 kg. per sq. cm., the actual values obtained being: 0·84, 0·88, 0·66, 1·08, 0·86, 1·20. These figures are of course very abnormally low, a reasonable value for a boiler plate of this kind being from 8·8 kg. to 11 kg. per sq. cm. It was thought that possibly this low value might be due to cold work which the plate had received, leaving it in a work-hardened and, possibly, internally strained condition. The impact tests were therefore repeated on specimens of the plate which had been annealed for 30 min. at 550 deg. C., in the same way as had been done with the tensile test-pieces. The mean result of six impact tests made on the steel in this condition gives a value of 2·90 kg. per sq. cm., the actual figures obtained being as follows: 2·10, 3·86, 2·64, 3·36, 3·52, 1·92.

Fig. 2.



It will be seen that this very low temperature annealing, by removing cold work and internal stress, has improved the impact behaviour of the material quite appreciably, but that, even when thus treated, it is still very far below the normal value for steel of this grade. This is indicated by the impact figures given on samples of the plate after normalising at 900 deg. C., when values of 10·78 and 11·72—mean, 11·25—kg. per sq. cm. were obtained.

It is evident from these figures that the steel of the fractured plate is in an abnormally bad condition, presumably as the result of some treatment—thermal or mechanical, or both—which it had received during manufacture, and it became necessary to discover, if possible, the cause of this abnormality.

The general microscopic examination of the steel showed at first sight nothing abnormal. The structure in general traverse and longitudinal section is shown under a magnification of 50 diam. in photomicrographs Figs. 3 and 4 (annexed). It will be seen that the scale of the structure, so far as ferrite-pearlite distribution is concerned, appears to be satisfactory, but there is a considerable amount of banding present, although this amount is not in itself abnormal for a plate of such large size.

More careful examination of the structure, however, particularly after it had been etched in such a way as to develop the ferrite boundaries, revealed a striking peculiarity. This takes the form of relatively very large ferrite crystals in the carbonless bands of the structure. These are illustrated, under a magnification of 150 diam., in Fig. 5 (above). The corresponding grain size of the same material, after normalising, is shown in Fig. 6 under the same magnification. It should be noted, however, that the normalised structure shown in Fig. 6 has been obtained not by treating a small laboratory sample but from a comparatively large piece of the plate about a foot square, which has been subjected to the heat treatment described. The most careful study of the steel in both conditions revealed no other difference between the "as received" and normalised conditions. The inference is thus indicated that the abnormal impact behaviour of the steel as received may be due to the development of coarse crystals in the carbonless bands which occur in this material, and the possibility is suggested that the failure of this plate may be connected

FIG. 3. × 50.

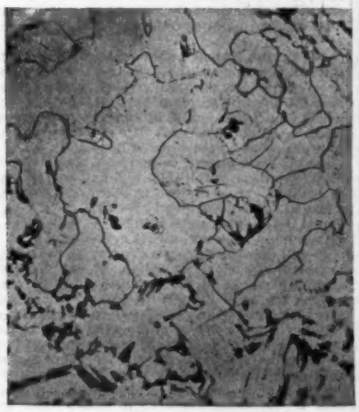


FIG. 5. × 150.

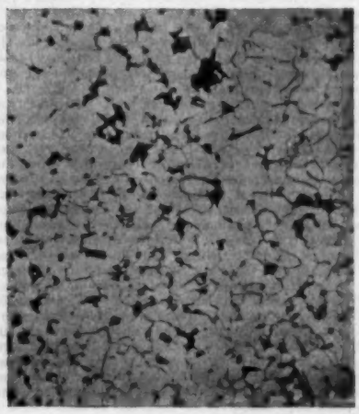


FIG. 6. × 150.

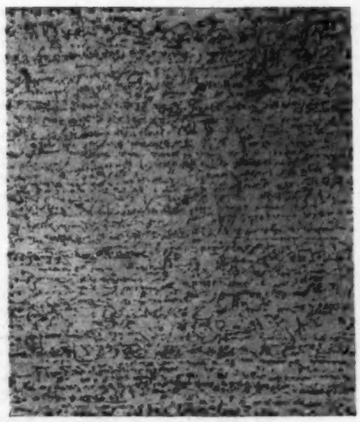


FIG. 4 × 50.

Reduced by one-third.

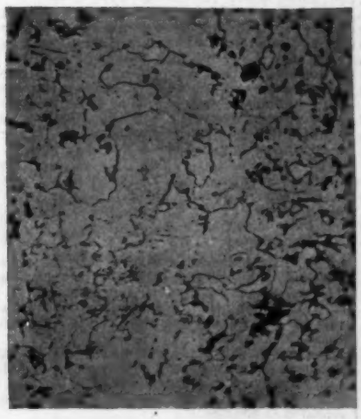


FIG. 7. × 150.

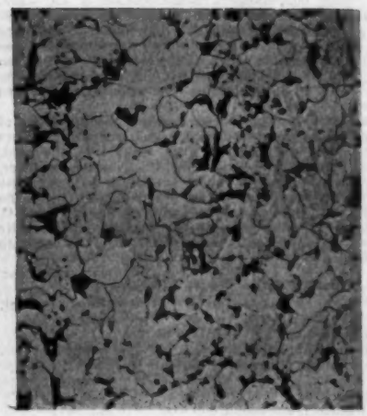


FIG. 8. × 150.

Reduced by one-third.

with the phenomenon of grain growth which has in recent years been discovered in the case of iron and very low carbon steel.

Since the subject of grain growth is of fundamental importance in connection with the further investigation of this plate, it will be desirable to refer to it in greater detail at this point.

Phenomena which are now recognised as coming under the general title of grain growth were discovered and described by Stead* and Charpy.† A considerable advance in our knowledge of the subject was, however, made by Sauveur,‡ who made the well-known experiment of straining by compression a conical piece of nearly pure iron, and subsequently annealing the piece thus treated at a temperature below the lowest critical point. On cutting a section and etching it, a band of very large ferrite crystals was found at one point, and this led to the view that there is a critical amount of plastic deformation which, for a given annealing temperature, below the critical range produces very rapid grain growth.

The subject has been more fully investigated by Chappell,§ and has also been dealt with in America by Sherry.‖ The latter author has shown that grain growth occurs, not only in comparatively pure iron, but in any region existing in a mass of mild steel from which pearlite is absent or nearly absent, *i.e.*, in the carbonless bands such as those met with in boiler plates, provided, of course, that the necessary treatment, consisting of plastic deformation of the right intensity followed by annealing at a correspondingly low temperature, has been applied.

In view of the results obtained by the authors just referred to, the observations made on the boiler plate which forms the subject of this paper at once suggested that the development of coarse ferrite crystals in the carbonless bands of the plate was the result of grain growth following upon deformation in the cold and subsequent low temperature annealing. When it is borne in mind that this plate was bent cold and then annealed several times in succession, it will be seen that the conditions likely to produce grain growth in carbon-free areas had been present. The authors, however, were not satisfied with a general inference of this kind, but endeavoured experimentally to reproduce the conditions under which the steel had developed the coarse and relatively brittle structure which it possessed when received. For this purpose two series of experiments were undertaken. In both series the material was first normalised in order to destroy the previously existing coarse crystals and to bring the material into the condition in which it gives a satisfactorily high impact figure. Deformation was then applied to the material in two ways; in one case, in the cold (by hammering), and in the second case at a temperature between 600 deg. C. and 700 deg. C., *i.e.*, below the critical range. Specimens treated in both ways were then annealed at 650 deg. C. for 30 minutes. The microstructure was examined both before and after this last annealing, and impact tests were taken on the material at each stage.

The resulting structure in one of the carbonless areas of the specimen which has been hammered in the cold, and subsequently annealed at 650 deg. C., is shown in Fig. 7, page 603, under a magnification of 150 diam. Comparison with Fig. 6 shows at once that considerable grain growth has taken place, although the resulting grains are not quite so large or well developed as those in Fig. 5. The sample which has been hammered between 600 deg. C. and 700 deg. C. gives a very similar structure, and the impact figure in this case is brought down to 1·56 kg. per sq. cm.

In order to test the matter further, another series of experiments was undertaken in which varying amounts of mechanical deformation were applied in the cold, followed by annealing at 650 deg. C. In order, however, to prove that it was not the annealing process alone which resulted in the reduction of the impact figure, the normalised sample was also annealed at 650 deg. C. without previous mechanical deformation. The results obtained by impact tests on specimens thus treated are given in Table II. :—

TABLE II.—*Boiler Plate No.* 1.

Treatment.	Resistance to Impact. Kg. per Sq. Cm.
Normalised at 900 deg. C. ...	10·46
Normalised at 900 deg. C. ...	8·92
Normalised; annealed at 650 deg. C.	9·04
Normalised; severely deformed; annealed, 650 deg. C.	11·70
Normalised; reduced 12·4 per cent.; annealed, 650 deg. C.	10·66
Normalised; reduced 7·1 per cent.; annealed, 650 deg. C.	8·44
Normalised; reduced 6·9 per cent.; annealed, 650 deg. C.	10·04
Normalised; reduced 4·9 per cent.; annealed, 650 deg. C.	8·14
Normalised; reduced 3 per cent.; annealed, 650 deg. C.	6·34

In this table the amount of mechanical deformation is measured by percentage reduction of thickness produced by pressing in the cold in a powerful hydraulic press.

The results given in Table II are instructive. It will be seen that large amounts of reduction actually improve the impact strength slightly, but with decreasing amounts of mechanical deformation followed by low temperature annealing the impact strength is very much reduced, although the lowest value obtained in this way, 6·34 kg. per sq. cm., is still very much better than that found in the plate in its condition as received, or that described in the hammered sample given above. There is nothing to suggest, however, that hammering, as distinct from such deformation as occurs in cold bending, has any specific effect. It should further be borne in mind that when a thick plate is bent in the cold, a considerable range of plastic deformation is produced, ranging from a maximum at the surface of the plate to zero at the neutral axis. Somewhere within this range the critical deformation, corresponding to the annealing temperature employed, is likely to occur.

The microstructure corresponding to the various forms of treatment referred to in Table II. are illustrated in Fig. 8, on page 693, and Figs. 9 and 10, on page 696. (The magnification in all cases is 150 diam.) Fig. 8 refers to the last specimen mentioned in the table, having the lowest impact figure and correspondingly showing the largest development of grain growth in the carbonless bands. Fig. 9 refers to the material as normalised and annealed at 650 deg. C. without intermediate deformation. It will be seen that here there is no appreciable difference in grain size between the carbonless band and the adjacent steel. Finally, Fig. 10 refers to the material which has been severely deformed and subsequently annealed at 650 deg. C., giving a high impact figure. Here it will be seen that the grain has been very much refined even in the carbonless areas, and this corresponds in a striking manner with the very high impact figure, 11·7.

When the evidence above described is carefully considered, it will be seen to afford a considerable degree of proof of the view that the brittleness, as evidenced by the very low impact figures and actual failure in manufacture which has been found in the plate under discussion, arises from the existence of coarse ferrite crystals due to grain growth in the carbonless bands of the steel, and that this grain-growth is the result of a moderate amount of deformation in the cold, followed by low temperature annealing. It is further evident that normalising the material, or indeed merely heating it to a temperature above the critical range, is sufficient entirely to obliterate this grain growth and all its evil effects.

It will be seen that this conclusion indicates that the presence of carbonless bands, which is regarded as a normal feature and has not hitherto been considered a serious source of danger or weakness in a boiler plate, may become the cause of failure if associated with a suitable combination of mechanical deformation and low temperature annealing. If carbonless bands are to be regarded as a normal feature in boiler plates—and in existing practice this is probably inevitable—and if deformation in the cold, such as bending, &c., is otherwise a desirable practice, it seems that subsequent normalising is necessary, or certainly desirable, as a safeguard against dangers of the kind described here.

In order further to test the view which has been advanced above, the authors have endeavoured to carry out similar experiments and tests on other samples of boiler plate, but the other samples at their disposal came in every case from plates of much smaller size and thickness, with the result that the banding, where it existed to a marked extent, was on a much smaller scale. Experiments on these plates were, however, made, in order that the results might be regarded as a check on the observations already described. In the case of a plate ½ in. thick, which may be referred to as No. 2, the chemical analysis was as follows :—

	Per cent.
Carbon	0·123
Silicon	0·014
Sulphur	0·03
Phosphorus	0·057
Manganese	0·49

which again indicates a steel of very satisfactory composition. The general microstructure of this plate in the condition as received is shown in Fig. 11, page 696. It will be seen that a certain amount of banding is present, but not on the scale found in the first plate described above.

A piece of this plate was normalised at 950 deg. C., and portions were subsequently treated as follows :—

1. Hammered cold and annealed at 650 deg. C.
2. Hammered between 600 deg. C. and 700 deg. C., and annealed at 650 deg. C.
3. Annealed at 650 deg. C. without previous mechanical treatment.

Impact tests have subsequently been carried out on the samples thus treated, with the results given in Table III. :—

TABLE III.—*Boiler Plate No.* 2.

Treatment.	Energy to Fracture. Kg.
As normalised at 950 deg. C.... ...	11·06
Normalised at 950 deg. C.; hammered cold and annealed at 650 deg. C.	5·52
Normalised, 950 deg. C.; hammered between 600 deg. C. and 700 deg. C., and annealed at 650 deg. C.	7·18
Normalised at 950 deg. C., annealed at 650 deg. C. without mechanical treatment... ...	10·44

It will be seen that the normalised material again gives a high value, and that this value is not appreciably diminished by a further annealing at 650 deg. C. On the other hand, cold hammering followed by annealing at 650 deg. C. lowers the impact figure to one-half of the normal value, while hammering between 600 deg. C. and 700 deg. C. reduces it considerably but to a lesser extent. The corresponding microstructures are illustrated in Figs. 12, 13, 14 and 15, on page 696. Fig. 12 shows the material as normalised, Fig. 13 shows it after normalising and re-annealed at 650 deg. C. without mechanical treatment, Fig. 14 shows the effects of cold hammering followed by annealing at 650 deg. C., and Fig. 15 shows the effect of hammering between 600 deg. C. and 700 deg. C., followed by annealing at 650 deg. C.

It will be seen that, in general terms, the results obtained with this material are of the same kind as those found in the first plate, but, probably owing to the smaller scale of the banding originally existing in this steel, the results are not quite so intense in character. It may be mentioned that this plate also had failed in practice, but not during manufacture, and in a manner which is not necessarily related to the phenomenon of grain growth. The experiments on this plate, however, serve to confirm the observations made with the first example, but they indicate that in plates of a smaller thickness the effects are not likely to be so serious as in the larger plates.

By way of a further check, similar experiments have been carried out on a further plate (plate No. 3), also ½ in. thick, which is practically free from banding. The chemical analysis of this plate is as follows :—

	Per cent.
Carbon	0·213
Silicon	0·059
Sulphur	0·032
Phosphorus	0·048
Manganese	0·700

The general microstructure of this plate is shown in Fig. 16, page 696. The absence of any marked banding will be noticed.

Impact tests have been made on specimens from this plate, both in the condition as received and after thermal and mechanical treatment similar to that which has been applied in the other cases. The results are given in Table IV. :—

TABLE IV.—*Boiler Plate No.* 3.

Treatment.	Impact Energy to Fracture.
As received	11·5
Reduced cold about 3 per cent.; annealed, 650 deg. C. ...	11·02 10·52
Reduced hot about 3 per cent.; annealed, 650 deg. C. ...	12·38 10·70
Annealed 650 deg. C., without mechanical treatment ...	11·24 11·68

It will be seen that in this plate cold hammering and hammering between 600 deg. C. and 700 deg. C. followed by annealing at 650 deg. C. does not affect the impact figure, and microscopic examination shows correspondingly that no grain growth has taken place.

The results obtained with plates Nos. 2 and 3 thus confirm the view that the low impact figures found in the first plate, and to a lesser extent in plate No. 2, are associated with the coarse crystal structure in the carbonless bands, and that these are the result of grain growth produced by slight deformation and subsequent low-temperature annealing; also that normalising in every case completely removes this source of weakness.

The authors are indebted to the Director of the National Physical Laboratory, Sir Richard T. Glazebrook, C.B., F.R.S., for his interest in the work, and to several of their colleagues for assistance in carrying it out, notably to Mr. R. G. Batson, A.K.C., A.M.Inst.C.E., of the Engineering Department of the Laboratory, who has carried out the mechanical tests described in the paper. The authors are also indebted to the various authorities concerned for their permission to utilise the materials and some of the data referred to in this paper.

BRITAIN AND GERMANY IN ALLIED MARKETS.—The pre-war positions of Britain and Germany in the markets of countries that are now our Allies is of special interest. It must be noted that the United States, South American countries and China are not included in this table. The figures are taken from the Report of the Engineering Trades After War Committee.

Exports of Machinery (and parts) to France, Russia, Italy, Belgium, Portugal, Serbia, Montenegro, Roumania, and Japan.

Year 1912.	From Britain. £	From Germany. £
Rail locomotives ...	50,225	614,000
Road locomotives ...	49,384	565,000
Agricultural engines ...	500,388	47,000
Pumping engines ...	167,035	238,000
Winding engines ...	7,509	192,000
Other engines	1,040,930	2,582,000
Electrical machinery ...	527,315	1,205,000
Agricultural machinery	664,939	1,569,000
Boilers	434,411	185,000
Machine tools	377,729	1,995,000
Mining machinery ...	53,837	111,000
Sewing machinery ...	1,037,161	1,155,000
Textile machinery ...	2,728,785	1,383,000
Typewriters	13,902	135,000
Ships' machinery ...	252,513	—
Totals	9,676,724	15,578,000

These figures are only roughly comparable. The classifications are different in the two countries, as the report states, but there are other modifying circumstances. Gas, oil and petrol engines are included in "other engines," as neither country separately classified them.

* Stead, Journal of the Iron and Steel Institute, 1898, No. I., p. 145; *ibid.*, No. II., p. 137.
† Charpy, "Comptes Rendus," vol. cli.
‡ Sauveur, Proceedings of the International Congress for Testing Materials, Sixth Congress, 1912, vol. xi.
§ Chappell, Journal of the Iron and Steel Institute, 1914, No. I., p. 460.
‖ Sherry, Faraday Society, December, 1916.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—The usual speeding-up which invariably marks the period immediately preceding the annual Fair Holidays is very much in evidence this year, and in every steel-making establishment in the Glasgow district strenuous endeavours are being made to maintain outputs at the maximum, a fact which ought to be specially gratifying to the Ministry of Munitions, in view of the request issued recently. While the bulk of the work continues to be on Government account—munitions, plates, sections and other parts for the shipbuilding yards, and material of one kind or another required for railway constructional and repair purposes—quite a fair tonnage is now available for ordinary mercantile use, both for home and export. Were transport conditions more favourable, overseas shipments could be very considerably increased at the present time.

Malleable Iron Trade.—Makers of malleable iron have many more orders on their books at the present time than it is possible for them to deal with, and in consequence they are much pressed for the delivery of the more urgent requirements wanted, directly or indirectly, on behalf of Government, which is still the principal consumer. There is a very heavy demand for the smaller sections, and a steadily increasing demand for bars of a larger diameter. The steel departments are actively employed rolling shell discard steel, and light rails and other sections required for work of national importance. Naturally, export business receives but scant consideration in the meantime.

Scotch Pig-Iron Trade.—Neither in demand nor in output is there any falling-off in the pig-iron industry, the smelters being as busily employed as ever. Notwithstanding the extensive output of hematite, every ton produced is speedily absorbed, almost entirely on Government contracts. Only a very small percentage of the output is available for shipment abroad, consequently few licences are granted, and prices, while firm, are, to a certain extent, merely nominal.

Clyde Shipbuilding Record.—Unusual interest attaches to an achievement which has just been accomplished by Messrs. Harland and Wolff at their Govan Yard—an achievement unique in the annals of shipbuilding. In completely constructing and handing over to the owners in less than seven months an oil-carrying vessel of 8,000 tons gross, they have established what is probably a world's record, eleven months having recently been suggested by a competent authority as the shortest period in which such a vessel could be completed. The feat is all the more remarkable when it is taken into account that a vessel of this type involves considerably more work than does one of the ordinary design.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The Small Tools Difficulty.—Since writing the note on this subject last week, there has been practically no change in the position. The manufacturers of small tools, who are not at all pleased with the requirements of the Ministry of Munitions' Order, are still awaiting the requested interview with Mr. Churchill, or representatives of his Department, and in the meantime, although the Order has had a fortnight's official existence, it has, so far, practically been ignored; manufacturers proceeding just as they did before the unpopular regulation was sprung upon them. Last week the Department of the Controller of Machine Tools sent out a circular to the manufacturers affected, explaining that the object of the Order, was merely to discover cases of overcharging and profiteering in connection with small tools.

File Trade Association.—With the brisk conditions prevailing in the file trade, come signs of a marked revival of activity in the File Manufacturer's Association, a very old body, which is at present showing a new life and healthy enterprise. It is intended to remodel its organisation, and to make the Association the principal agency for advancing the best interests of the file trade. With that object in view, the membership of the Association is to be extended to individuals heretofore ineligible; the Sheffield University authorities are to be approached for the use of a room for meetings and an ambitious programme of lectures has been projected.

Iron and Steel.—Trade conditions continue on the downward trend, although almost imperceptibly so. It is almost impossible to discover a department at the moment which is not meeting the demands made upon it with an ease that is most marked, compared with the feverish production which has been experienced in past months. The demand for crucible steel is decidedly easy, large stocks of this material, as well as of alloy steel, having accumulated, with the result that a reserve that should be equal to meeting any unexpected pressure in the immediate future has been set up. Supplies of pig-iron are coming to hand now a little more satisfactorily, but there is still a dearth of forge and foundry iron. The scrap supply is somewhat "mixed," some sorts being easily obtainable, while others are very short. Steel makers would welcome an improvement in the scrap supply. Iron foundries are strongly seeking old cast-iron scrap, the price of which, in consequence of the very heavy demand, has been sent up very considerably.

South Yorkshire Coal Trade.—The state of the coal trade changes very little, and what change there has been lately has not been in the nature of an improvement. Free fuel continues to be most entirely absent from the market. Contractors are absorbing, in respect of long overdue orders, the whole of the reduced output. The demand for best steams continues strong, neither the inland nor the exports demands showing any tendency to decline. Cobbles, nuts and slacks are in big request, but there is absolutely nothing available for open sales. There is a scarcity in household sorts, and the shortage in local depots is acute. Merchants complain of great arrears in the orders on their books. Cokes are firm and difficult. Best branch hand-picked, 23*s.* to 24*s.*; Barnsley best Silkstone, 23*s.* to 23*s.* 6*d.*; Derbyshire best brights, 21*s.* to 22*s.*; Derbyshire house coal, 18*s.* 6*d.* to 19*s.* 6*d.*; best large nuts, 18*s.* 6*d.* to 19*s.* 6*d.*; small nuts, 17*s.* 6*d.* to 18*s.* 6*d.*; Yorkshire hards, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire hards, 17*s.* 9*d.* to 18*s.* 9*d.*; best slacks, 14*s.* to 14*s.* 6*d.*; seconds, 13*s.* to 13*s.* 6*d.*; smalls, 9*s.* to 10*s.* per ton at the pit.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Better and still improving facilities for distribution assure June home deliveries of pig-iron to be the largest of any month this year. Substantial supplementary allocations of foundry quality for Scotland are coming forward, and all the North of England foundries are fully engaged. Lessened demand, however, is likely to be experienced in the near future, as next week Tyneside foundries will suspend operations for the local holidays, and next month holiday week in Scotland will be observed. Meanwhile, however, there is considerable pressure for delivery. Production and delivery of forge iron has, of late, been on a scale large enough to enable consumers to accumulate stocks, so that there is no longer pressure for delivery of this quality, but there are a few inquiries in the market. With tonnage more plentiful, shipments to France are large, and exports to Italy better, but trade with the latter country is retarded to some extent by difficulty in connection with the rate of exchange. For home consumption, No. 3 Cleveland pig-iron, No. 4 foundry, and No. 4 forge, all stand at 95*s.*, and No. 1 is 99*s.*; and for shipment to France and Italy No. 3 and the lower qualities are quoted 114*s.*, and No. 1 is 119*s.*

Hematite Iron.—Home consumers of East-Coast hematite are obtaining quite adequate supplies, improved railing facilities having resulted in larger deliveries, whilst exports are better, and all round, the hematite branch shows greater activity. Whilst the entire output is promptly taken up, there is no actual shortage. Continued very extensive use of basic iron and scrap for steel making assist materially to keep conditions healthy. Mixed numbers of hematite are 122*s.* 6*d.* for home use, and 147*s.* 6*d.* for export to France and Italy.

Manufactured Iron and Steel.—There is no abatement in the huge demand for finished iron and steel, but whilst the enormous production is not sufficient fully to satisfy all needs, it is pleasing to know that manufacturers of shipbuilding material continue to keep ahead of shipyard requirements. Directly or indirectly, steelworks are engaged exclusively on war work, and little opportunity is afforded for the transaction of ordinary commercial business. Quotations all round are very strong. For home consumption, common iron bars are 13*l.* 17*s.* 6*d.*; best bars, 14*l.* 5*s.*; best best bars, 14*l.* 12*s.* 6*d.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 17*s.* 6*d.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 12*l.* 10*s.*; steel hoops, 17*l.* 10*s.*; and heavy steel rails, 10*l.* 17*s.* 6*d.* There are no fixed prices for export, but, approximately they may be given at 40*s.* to 60*s.* per ton above home quotations.

Coke.—Coke is still very scarce, but the shortage for home use appears to be a little less pronounced, and better supplies are looked for. Consumers continue to experience some inconvenience in consequence of receiving hardly adequate supplies. Next to none is now obtainable for neutrals. For home use, foundry kind is 38*s.*; average blast-furnace quality, 33*s.* at the ovens; and low phosphorus sort, 35*s.* 6*d.* at the ovens; whilst 55*s.* is named for both foundry and furnace coke for neutrals.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—The authorities are still absorbing practically all the outputs of large coals that are reaching the markets. Here and there merchants are able to obtain small odd parcels for prompt shipment, but the aggregate quantity released in this way is extremely small, and with production below normal, there appears very little immediate prospect of an extension of private dealings. Owing chiefly to the diminished bunker demand, there is a better supply of ordinary smalls than has been the case for some time past, but washed smalls, as well as nuts and beans, are relatively scarce. The general conditions this week are easier, the demand not being nearly as pressing as it has been for the past two or three months. The easiness which began to affect inferior smalls a week ago has now extended to all classes of small coals, and although the banking of these coals has not yet been recommenced, the quantity standing on the sidings is increasing. There is a good inquiry for the better classes of bituminous coals. Pitwood and iron ore continue in good supply.

Irregular Stoppages in the Coalfield.—There has now been an appreciable diminution in the number of irregular stoppages in the South Wales coalfield. They are still, however, occurring here and there, notwithstanding the fact that the Joint Standing Committee of the Conciliation Board meets weekly in order to deal expeditiously with labour troubles, and so avert stoppages. At the last meeting of the Committee, held yesterday, the owners again entered a protest against these stoppages, inasmuch as on the occasion of the appointment of the Committee, the men's leaders gave an undertaking that all disputes would be reported to the Committee before any stoppages should take place. Apparently, however, the leaders in many instances are unable to exercise the necessary discipline over the men whom they represent.

Newport.—The market for Monmouthshire coals has lost a little of the firmness which has characterised it for the past few months. Some of the inferior smalls are, for the moment, almost a glut. Even bunker descriptions are relatively plentiful, but there is a good demand for coking smalls. Black veins also are shipped heavily on official account, and locomotive coals are also inquired for, both for shipment and for inland consumption.

The Coal Exporters' Brokerage.—A special meeting of coal exporters was held on the Cardiff Exchange yesterday, when Mr. T. J. Callaghan, the president of the Chamber of Commerce, reported upon the terms of the compromise arranged over the brokerage question. These are to the effect that exporters will be allowed to retain the one-third of 5 per cent. brokerage on shipments to France and Italy, to hand over to the collieries 50 per cent. of their maximum commission of 1*s.* on such shipments, and, in regard to shipments to neutral destinations, are to retain only the commission of not less than 5 per cent. There was a general desire expressed that the new amended Order, when published, should be free of any ambiguity as to the position of British Possessions, and the chairman (who is to meet the Coal Controller on the subject) was authorised to make every possible effort to secure for shipments to British coaling stations exactly the same terms as those applicable to France and Italy. One or two points were made clear. One is that Portugal comes within the definition of neutral countries. It was also intimated that the Order of the Coal Controller, of March 2 last, instructing exporters to pay over the brokerage in full to the owners of the collieries, will continue in force until the date fixed in the new Order.

NOTICE OF MEETING.

THE PHYSICAL SOCIETY OF LONDON.—Friday, June 28, at 5 p.m., at the Imperial College of Science, Imperial Institute Road, South Kensington, S.W. Agenda:—1. "A New Method of Measuring Alternating Currents and Electric Oscillations," by Mr. I. Williams, M.Sc. 2. "A Demonstration of Coupled Vibrations," by Professor E. H. Barton, F.R.S., and Miss H. M. Browning, B.Sc.

SHEFFIELD UNIVERSITY DEGREES.—Lord Crewe, Chancellor of the Sheffield University, is expected to confer honorary degrees at the Degree Congregation, on the 29th inst. The Japanese Ambassador, Viscount Chinda, and Sir Eric Geddes, First Lord of the Admiralty, are to receive the LL.D. The honorary degree of D.Eng. will be conferred on Sir W. H. Ellis, Master Cutler, G.B.E., and that of M.Eng. on Mr. G. Blake Walker.

THE SECRETARY OF STATE FOR THE AIR FORCES.—The King has been graciously pleased to approve that the dignity of a Peerage of the United Kingdom be conferred upon the Right Hon. Sir William Weir, Secretary of State for the Air Forces. Sir William Weir is a partner in the Glasgow engineering firm of G. and J. Weir (Limited), Cathcart; he has been engaged almost wholly on war work since the formation of the Ministry of Munitions in 1915. We referred to his activities in this connection in a former article, on page 496 *ante*.

RESEARCH WORK AT GLASGOW TECHNICAL COLLEGE.—Some time before the outbreak of war, says *The Glasgow Herald*, the Governors of the Royal Technical College, Glasgow, received an anonymous donation of 10,000*l.* (on condition that another 15,000*l.* was raised) for the purpose of providing an endowment which would enable the principal departments of the College to undertake definite research work. At a meeting of the governors held on Tuesday, the 18th inst., at the College—Dr. James Mackenzie presiding—the announcement was made that Mr. Francis Henderson, a member of the board, had intimated a donation of 1,000*l.* towards the fund. The chairman remarked that in his letter, Mr. Henderson suggested that it was very important that the money should be raised for the endowment of research. When the war came to an end, they would be in a position to develop this side of technical science to the utmost, and to extend very largely the present limited amount of research, if funds permitted. They had already raised practically 20,000*l.*, and they hoped before very long to reach 25,000*l.*, or exceed that figure. He proposed a hearty vote of thanks to Mr. Henderson for his gift, and also asked that the thanks of the governors be conveyed to Messrs. Begg, Sutherland and Co., London, for a donation of 20*l.* a year for five years to the Lectureship in sugar manufacture. Sir Donald Mac Alister, who seconded the motion, said that after the war, when they were ready to resume operations, the fund would be of the utmost significance. He was delighted to hear that the goal they aspired to was almost within sight, and if the generous impulse of Mr. Henderson could be communicated to five or six others they would attain what they originally intended. In the minutes of the Committee on Chemistry and Metallurgy, submitted by Mr. Chrystal, it was stated that Sir George Beilby, director of the Fuel Research Board, was in need of a chemist of the first rank to act as organiser on the chemical side of the Fuel Research station at East Greenwich. He asked that Professor Gray be lent to the department for a period of two or possibly three years, and the committee recommended that the services of Dr. Gray be lent as proposed. The minute was adopted unanimously.

A CAUSE OF FAILURE IN BOILER PLATES.

(*For Description, see Page 692.*)

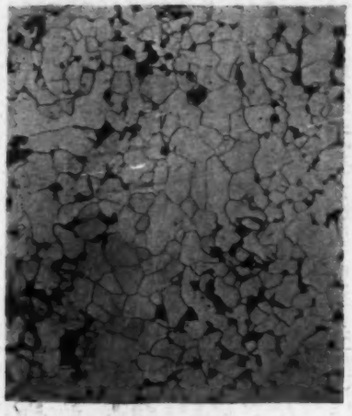


FIG. 9. × 150.

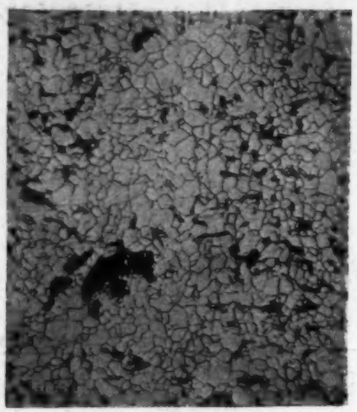


FIG. 10. × 150.

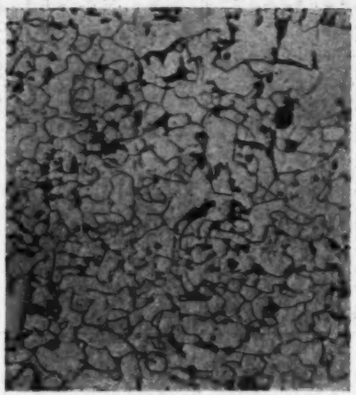


FIG. 13. × 150.

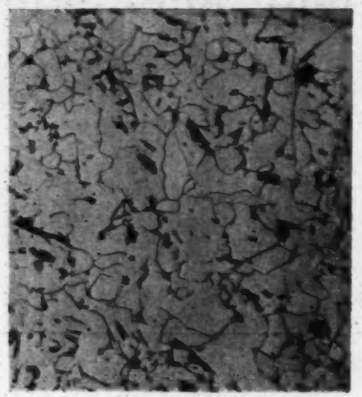


FIG. 14. × 150.

FIG. 11. × 50.

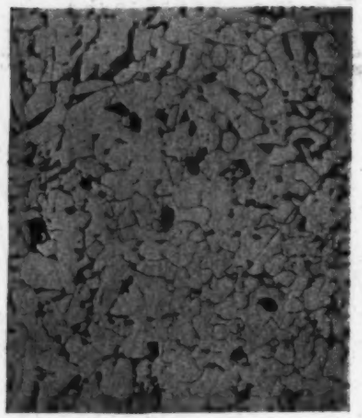


FIG. 12. × 150.

Reduced by one-third.

FIG. 15. × 150.

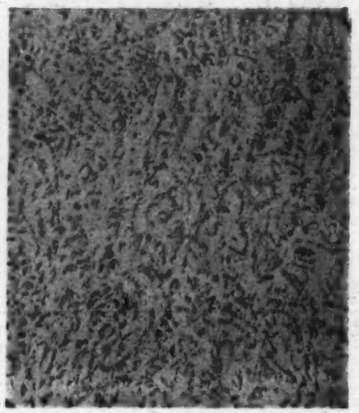


FIG. 16. × 50.

Reduced by one-third.

THE FUTURE OF THE GERMAN STEEL UNIONS.—At the recent general meeting of the Union of German Ironworks, the president of the union, General Director Vögler, of the German Luxemburg Company, touched upon the future of the unions within the German iron industry, emphasising that the period following the war would be a bitter, serious and troublous time. What had been destroyed during the long war would have to be built up again, but the question of regaining the lost international market formed a specially difficult problem to solve. In this connection the question arose as to whether it was necessary to strengthen and protect the iron industry within the home country, and the opinions concerning the value of such unions diverged. The view might be taken that after the war it would be easier for individual works, with their greater freedom of action, to regain a footing abroad, than for the more heavily-moving unions; there was, however, the danger that owing to the unsettled and confused condition of the world's market, many a national, valuable asset might be dissipated if individual action obtained. Further, the authorities had informed the iron works in the plainest possible manner, that pressure from above would take effect if no voluntary combine was brought about. With regard to the "pressure from above," it had been pointed out that whilst the Government has often denounced compulsory unions or syndicates in principle it does not appear to hesitate to agree to combination in isolated cases when found expedient, and when the industries either do not mean to form or cannot agree in forming voluntary unions. As regards a steel union, formed under pressure from above and including the by-products, that is to say the more completely manufactured articles in large quantities, there are undoubtedly not a few works who have serious misgivings as to the effect of such a union on the German export trade within this branch. The export of a large series of steel products through the medium of a large union, however ably such a union is managed commercially, may suffer from bureaucratic organisation, and might be better pushed by a number of enterprising business undertakings acting independently. And this bureaucratic influence is all the more to be avoided, the opponents to compulsory unions maintain, because sundry means for furthering the export trade before the war were anything but popular in many quarters, both at home and abroad, and cannot now be adopted again on a comprehensive scale. This specially refers to the selling of goods to foreign countries at prices which were below the home quotations. And the temptation to adopt such or kindred measures is greater for the unions, than for the individual works. When, in spite of this, a steel union, including the by-products, is considered desirable by a large number of works, it is not so much on account of an expected increase of the foreign trade as in the interest of a consolidation of the home prices. The Government is urged not to lose sight of this view when contemplating the necessity of bringing pressure to bear on the industry. The last report of the work of the Steel Union states that the position of the market remains about the same. During the last few months production had somewhat decreased owing to inadequate supplies of fuel, but matters appeared to be mending owing to further rolling-stock being available.

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Turner and Henderson, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.
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EDINBURGH: John Menzies and Co., 12, Hanover-street.
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With Four One-Page Plates of the DERWENT VALLEY WATER WORKS.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal further from 6d. to 9d. per copy. This increase dates from and includes the issue of Friday, March 1, 1918. The change will not apply to unexpired subscriptions. The revised rates for new subscriptions are given in the adjoining column.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents after June 24th will not have copies for chance customers, therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 695.

ENGINEERING.

FRIDAY, JUNE 21, 1918.

POST-WAR CONDITIONS AND THE ENGINEERING TRADES.

WE commend to the careful consideration of all engineers the report, just issued, on engineering trade after the war, prepared by the Departmental Committee appointed by the Board of Trade to consider the whole question. Not only does it contain much useful information, as the result of evidence from 31 different branches of the engineering industry, but the whole position is reviewed in a judicial spirit, and without that somewhat extreme tendency which the incidents of the war have developed in the consideration of international problems. We have ourselves expressed the conviction that dumping must cease, because while it is euphemistically regarded as an economical question, there is no doubt that, alike in intention and certainly in result, it has, to a greater or less extent, atrophied some of our more important trades. The subject of protection *per se* requires much more thoughtful consideration. Our policy towards the Dominions must be taken into account and, for obvious reasons, must have a primary place. Our allies, too, must have "favoured nation" treatment, and in this connection the Government have done well in abrogating all treaties, in order that we may, after the war, begin with a clean sheet of paper. But protection *per se* must be adopted with very great caution. Entirely new industries, and even pivotal trades, may require support, but it is a sound axiom that as soon as a trade becomes self-supporting any artificial aid decreases its vigour and diminishes its vitality.

In the report under notice the Committee recommend, as regards enemy goods, that, in order to give time for the reorganisation of the engineering works of the country on a business footing after the war, the importation of enemy engineering products into the United Kingdom should be prohibited, except under license, for a minimum period of one year, and for such longer period as may be deemed expedient. Again, in order to encourage trade between the present allies, it is suggested that they be invited, without interference with their existing fiscal systems, to consider the imposition of an additional duty or surtax over and above their normal duties, to be levied solely against the products of the present enemy countries, such surtax to be subject to progressive diminution; while this country should impose a duty equal to such surtax on the products of present enemy countries, also to be subject to a like progressive diminution. Raw materials, however, they suggest should be admitted duty free, and that a Government department should be charged with the duty of exercising vigilance over the adequate provision in this country of manufactures which are at any time essential to the national safety, as distinct from our staple trades. Thus, the supply of tungsten and magnetos, and similar essentials, should be carefully safeguarded for the benefit of the empire, and the supply of raw materials for essential industries should be supervised, encouraged and assisted. Dumping, of course, is regarded as a suitable subject for prohibitive legislation.

The suggestions made by the Committee for what one might term the "vitalising" of British industries are, in every case, commendable. One discouraging practice in the past has been the refusal of the Treasury to encourage the building up by firms of a large depreciation account. In determining profits for income tax they have refused to allow an adequate rate of depreciation on plant. This, for many years, has been a legitimate cause of dissatisfaction. There is little use in improving our educational system and stimulating inventive ingenuity if the great manufacturing firms are prevented from accumulating a fund, in order that the inventions and mechanical improvements consequent on this higher degree of mentality shall have a fair chance of adoption. Moreover, general prosperity, as well as increased amity between employer and worker, can only be attained by an increased rate of output per unit of physical effort and per pound sterling expended, either in wages or charges. It follows that the mechanical appliances at the service of the worker must be the most efficient attainable, and until manufacturers are stimulated to make preparation, by creating a large depreciation and obsolescence fund, we shall not attain that efficiency in production which is essential to national progress and solvency. Moreover, the immediate requirements are for intensified production, not only to justify the existing inflated rate of wage—which we fear cannot be reduced for some time—but in order that the wastage of the war shall be repaired as speedily as possible. The Committee are, consequently, to be commended for their proposal that, to encourage renewals, actual depreciation of machinery and plant be allowed by the income tax authorities up to 15 per cent., with a reasonable rate on buildings.

The question of the control of manufactures by the Government is one on which all industrialists, whether employers or workers, are in harmony; the sooner it is removed, the better for industry. The Committee, in addition, recommend that allowances to firms under the Munitions Act should be left unimpaired, in order that they may be the better able to conduct post-war competition in the export markets. We fear that this view has been lost sight of in the inevitable desire to pay from revenue as large a proportion of the cost of the war as possible. We should have preferred that a smaller proportion of excess profit should be taken and that, under suitable guarantee, the proportion of profit thus liberated should have been conserved by each firm, to enable them the better to reconstruct their works and to modernise their plant, with a view of reducing the cost of production, while satisfying the claims of labour. It is idle to expect the continuance of high wages without increased output, if we are to hold our proper place amongst the great producing countries of the world, and consequently it is imperative that everything possible shall be done to enable the volume of output to be greatly increased and the cost to be reduced. This end can be attained not only by standardising manufactures but by standardising works. The production of a multiplicity of articles in any one factory is not in consonance with works efficiency. In the interests of national prosperity firms are forced to combine, so that in any specific department of engineering activity there shall be such a distribution of orders as will ensure standardisation of factories. In the shipbuilding trade this has been accomplished under the stress of war, and each yard has allocated to it that size and type of ship for building for which it is best suited. This applies to marine engines, and there is no reason why in the future this method should not be carried out, under centralised control, by committees representing many firms, in order that the best results may be got from each factory. There is no need to enter into details. The important consideration is that combination shall not mean the growth of a factory beyond the limits of economic individual control; or that the consumer shall suffer owing to the artificial increase of selling price. There will be

no need for any such advance, as the system of standardising works for specific products, or even for predetermined sizes of products, will, of itself, so reduce costs as to give a satisfactory profit with high earnings for the men, without augmenting the selling price. The Committee therefore have done well in recommending that, in the interests of the country, the engineering manufacturers should be encouraged to work together in large units, either by amalgamation or by joint working, by pooling of resources, by specialising production, and by organising export sales and the purchase of raw materials.

There is a growing hope that the labour situation in the engineering trade, after the war, will be more stable than in pre-war days, because, notably, the necessities of the war have affected old standards and old ideas. The great majority of the workers have realised that their capacity is enormously greater than they thought it was, and that, too, without excessive tax on their physical strength. They must have recognised that the speeding-up of machine tools was advantageous not only to all paid by piece rates or by bonus, but also to the State, as it increased greatly the available implements of war. There is a bloodless war continuously in progress. We are all eager to advance, and therefore to increase that which will give us greater prosperity, at all events individually. The nation must therefore produce more than it consumes; it must secure a market for that excess production; otherwise there can be no increase in wealth, collective or individual. Consequently, each worker, whether mental or manual, must strive to increase his contribution in production to the common weal, and each is, of course, entitled to full remuneration. That remuneration will be the greater if, by efficient methods, the product can be sold at a lower price than that of our competitors. So that it is of the greatest importance that the best shall be got out of every unit of plant. The great trouble of the past, which must now be removed for all time, was the absence of trust on the part of the workers. To remove distrust it is essential that employers and those who represent them in the shops shall strive, not only to maintain satisfactory rates of wage, but shall do everything possible to enable high earnings to be won by improving mechanical appliances, and by expediting the progress of work so that there shall be no delays. The Committee lay stress on the importance of such cordial relations between employers and employed, the one maintaining the rates of wage and the other ensuring the maximum output and the elimination of all trade union regulations which are inimical to works efficiency. Much, too, can be done towards this increased trust by the education of apprentices, not only in conformity with the new Education Act, but by some degree of liberality in supporting promising youths who show the ability to profit by the teaching of the technical college and the university. Every employer should strive to realise not only the economic advantage of securing from among his little battalion of workers the best boys, but also of developing by this and other means *esprit de corps*, which is a most important factor in winning the confidence of the workers.

THE ADMIRALTY SALVAGE SECTION.

AFTER the war broke out the Admiralty developed a salvage section, a department which has unceasingly and successfully carried out, under extremely hazardous conditions generally, the salvage of ships which have been mined or torpedoed. Since October, 1915, down to the present time, as many as 400 ships, some of which are of a very high carrying capacity, have been salved by them. A large proportion of these ships have been ultimately repaired, refitted and put in commission afresh. In most instances their cargo, of foodstuffs or raw material, was saved and utilised in the country. It will readily be understood that in a number of cases, ships have been salved by the Admiralty, which, in pre-war times, would have been left to their fate, for the salving of a ship is but a commercial proposition, and before the war, the cost of raising a sunken ship might frequently exceed her value; before the war, in fact, it often occurred that a sunken ship was removed only when she obstructed a fairway. At the present time, however, it is worth while to salve practically every sunken ship, for the comparative shortage of ships and the consequent enhanced value of shipping following upon the war, have allowed a greater latitude in the expenditure upon salvage operations. The work to be carried out assumed, in course of time, such an extensive scope that the Admiralty decided to take it in hand directly, with the result briefly outlined above, a result which has been achieved by the experience gained in the work by the personnel, with the help of a plant and equipment greater than has been available for the purpose at any time and in any country.

It is not advisable at the present juncture to publish in detail the work of the section, nor to enlarge upon their plant, but a few separate instances of actual salvage operations carried out by them may be quoted. One was that of a large oil-tank steamer which had been mined, had caught fire and was eventually beached, floated off, and repaired. The steamer, after striking the mine, blazed away to such an extent that the tugs and salvage ships had great difficulty in approaching her. When she had been towed into relatively shallow water, shots were fired into her, and she was made to sink, thus putting out the flames. The holes in the steamer were then plugged by divers; she was afterwards pumped out, refloated, and taken to the repairing yard. The cost of salvage was much less than the cost of the steamer. A part of her cargo was also saved. We may here add that one of the great aids to salvage operations is found to be the submersible electric-driven motor pump, some types of which can deliver 500 tons per hour to a height of 75 ft. to 80 ft. We gave a brief description of these pumps in former issues (see ENGINEERING, vol. xci, page 312, and vol. xciii, page 595).

A vessel carrying a cargo of foodstuffs to the combined value of over 3,000,000*l.*, after being torpedoed, was taken in tow by the section's tugboats. She sank before she could be left high up on the beach; at low water she was just awash for about two hours in the day. Electrically-driven submersible pumps were put down in the stokeholds; divers went down through the tunnel doors and established communication between the flooded holds and the stokeholds. After making the parts thus involved watertight on the outside, the pumps were started working together, and the vessel being thus lightened, could be drawn higher up on the beach,when similar operations were effected in the lower submerged quarters. Thousands of tons of cargo, principally the foodstuffs, were saved, and the vessel was ultimately floated off and repaired.

A ship of modern construction, of about 14,000 tons, valued together with her cargo at 3,500,000*l.*, was saved together with a considerable part of the cargo in a very similar manner.

A large Government collier, partly filled with coal, was sunk by collision in 12 fathoms of water, partially blocking a very important channel and anchorage. Her removal was a matter of urgent necessity, but, owing to strong tides and chances of bad weather, it was not possible to use cofferdams or other methods of that description. There was no alternative but demolition by explosives, or an attempt at lifting by means of pontoons. It was decided to attempt the lifting; the weight was calculated at 3,500 tons, including the mud which had accumulated. It was proposed to reduce this weight to about 2,800 tons, by emptying the ballast tanks and forepeak by using compressed air. The connections were made by divers for this purpose. The vessel had sunk into the mud past the turn of the bilge, and the prospects did not at first appear very encouraging, especially as another, deep-draught vessel, coming up the channel, had crushed down all deckhouses, &c., flush with the deck. Considerable difficulty was experienced in getting the wire-lifting ropes under the vessel, on account of her being so deep in the mud. After a great deal of sweeping work with the salvage vessels, sixteen 9-in. wire ropes were eventually placed under the bottom and brought up to four Admiralty lifting craft, placed over the wreck. The water was then emptied by compressed air from the ballast tanks and forepeak, and the first lift was successfully made. The collier was thus carried a distance of over one mile, and moved inshore clear of the anchorage. Several other lifts were subsequently made, and the vessel was gradually carried along until her decks were almost dry at low water. Divers then roughly patched the hole, and powerful pumps were started, the vessel pumped out and floated. She duly arrived in port, was repaired, after which she made many useful voyages.

The salvage operations are often conducted under very hazardous conditions through many causes, and work which has taken days to perform is sometimes swept away by a single heavy sea. The cargoes of foodstuffs, even when the ships themselves are salved, cannot always be saved. One of the greatest troubles the section have had to contend with has been the accumulation of gas in the holds of sunken vessels, due to decomposed vegetable matter, decayed meat, &c. In some instances, the sulphuretted hydrogen gas developed in a grain cargo has had to be contended with after a ship has been raised; a chemist has, however, developed during the war a substance which immediately kills the noxious gases, and the men are able to carry on their work freely as soon as the presence of the gases is discovered, and the rotting cargoes have been sprayed with the preparation.

At the offices of the salvage section can be seen a model of a standard patch which has proved most effective in its application to vessels which have been torpedoed. One ship which had been torpedoed in the after-hold on one side was fitted with one of these standard patches, and started under her own steam for port. On the run, she was torpedoed from the opposite side abreast of the repaired plates, the explosion blowing off a small portion of the patch; the ship was further patched up, reached port, and was made seaworthy again.

The Admiralty are to be congratulated on the very great service they are in this direction rendering to the Empire, and so are the officers and men engaged in the operations. There is no maritime work, apart from war operations, which make greater demands for skill and courage than salvage.

ELECTRIC POWER SUPPLY.

PERHAPS the most remarkable criticism with which the "Interim Report on Electric Power Supply in Great Britain" was met, was the complaint brought forward in several popular journals, that this committee, constituted to report on a highly technical matter, consisted solely of experts, and did not include Alderman X, chairman of the electrical committee of the borough of Y, or Councillor A, who occupied a similar position with respect to the electrical undertaking of the city of C. The complaint was not that certain very capable corporation electrical engineers, were not included on the committee, but that a place on it was not found for certain politicians. This distrust of the engineer appears, unfortunately, to be by no means confined to one political party. The House of Lords recently rejected the Lochaber power scheme, and saddled their consent to the reconstruction of the Charing Cross bridge with some most inequitable conditions. These latter examples are, however, instances merely of indifference to informed opinion, and although their effect will, no doubt, be to handicap the country in its recovery from the wastage due to the war, the spirit shown is less serious than that responsible for the criticism of the constitution of the Power Supply Committee. Parliament is quite within its rights in rejecting expert opinion on the ground that other than purely technical questions may be at issue, but, on the other hand, it is of the utmost importance that the nation should know at first hand what this expert opinion may be, and that committees of inquiry into technical questions shall not be saddled with politicians appointed solely with a view to suppressing or emasculating inconvenient facts.

The Committee on Power Supply would, no doubt, have been glad to have included in their ranks any able municipal electrical engineer, but the latter would, in many cases, have felt a difficulty in accepting the nomination, since any report to which he could subscribe would, in the nature of things, be bound to be unpalatable to his employers.

Few municipal electrical engineers can, indeed,

afford to speak as frankly on such subjects as Mr. S. J. Watson has done in the admirable address which he delivered yesterday at Manchester to the Incorporated Municipal Electrical Association.

In the main, this address consists of a detailed study of the relative costs of distributing energy over large areas from super-power stations, and the generally existing system of numerous generating stations of relatively small individual capacity. Of course, however unwelcome to local authorities generally, the result of any such impartial inquiry was necessarily a foregone conclusion, but the great value of Mr. Watson's address lies in the carefully compiled detailed figures and estimates as to relative costs in the two cases.

As the basis of his investigation he has taken the Manchester district, an area of some 400 sq. miles, with a population of 2,500,000, which is claimed to be the most important manufacturing area in the country. This may well be true, although for many years past, possibly owing to the influence of the materialistic school of economics, of which Manchester has so long been the centre, Lancashire has preferred to copy rather than create. In the district in question Mr. Watson states that the power consumed amounts to half a horse-power per inhabitant, equivalent, were it all electrically generated, to a total installed capacity of 750,000 kw., which would represent, he states, a maximum demand of 450,000 kw. Actually, however, the electric-power plant in this area has an installed capacity of but some 185,000 kw., whilst the maximum load is 111,700 kw. This compares poorly with the north-east coast district, where it appears that, in spite of the lower density of population, the current consumption per head is about three times as much as in the Lancashire area taken as a whole. Mr. Watson claims that the relative slowness with which electric power has been developed in Lancashire, is, in part, at least, attributable to the fairly high efficiency of the steam plants already installed. Thus, whilst data obtained in the north-east coast area showed that the average coal consumption of factory engines was as much as 7 lb. per horse-power per hour, Mr. Watson holds that in the Manchester area a much higher average economy is reached. This is probably true, since many of the cotton-mill engines are large, and in a number of cases are of first-class design and make. Altogether, the average engine efficiency in the Lancashire area is, no doubt, much higher than the general average for the United Kingdom. In the future, Mr. Watson looks forward to a time when this important industrial area of 400 sq. miles, of which Manchester is the centre, will demand 5,000,000,000 units per annum, and a maximum load of 1,000,000 kw.

How is the supply to be furnished? At present the 185,000 kw. installed are divided up amongst no less than 18 stations. The average size of these is, accordingly, far too small, either for economy in capital cost, or in running expenses, or in the still more important matter of being financially in a position to secure the services of an adequate technical staff. Economies requiring skilled supervision, are practicable at a large station, but impossible in small ones. Large stations will, therefore, be essential, and Mr. Watson gives the following estimate as to the cost of such a station having a plant capacity of 100,000 kw., and designed for a maximum load of 75,000 kw. :—

		Cost per kw.
	£	£
Land and clearing ...	25,000	0·25
Sidings or wharves ...	40,000	0·40
Buildings, foundations, cold storage and handling	275,000	2·75
Engine-room equipment	310,000	3·10
Boiler-house equipment	210,000	2·10
Waterpipes, conduits, &c.	40,000	0·40
Total	£900,000	£9·00

The estimate is based on pre-war prices, no other course being practicable. When it is remembered that twenty years ago the cost of power stations per kilowatt installed was nearer 40*l.* than 30*l.*, the enormous debt which the world owes to the genius of Sir Charles Parsons can be appreciated. The gain, moreover, has not been in capital cost merely but also in running expenses. The turbine has reduced the cost of labour, lubricating oil and of fuel. In some recent tests we may note a consumption of 10 lb. of steam per kilowatt-hour at the switchboard has been recorded, the overall thermal efficiency of the plant being thus comparable with that of a good gas engine running on producer gas.

Quite properly, Mr. Watson, in estimating the annual costs of his proposed power station does not base his figures on record results of this kind, though it is highly probable that even better figures will be realised before long. For a load factor of 33·5 per cent. he considers that the thermal efficiency of the station may be 13·8 per cent., whilst if the load factor can be raised to 45·7 per cent. he thinks that a thermal efficiency of 15·3 per cent. should be secured. On this basis he estimates that the annual costs of the station will be as shown in the annexed table.

Plant Installed ..	100,000 kw.			100,000 kw.	
Maximum Load ..	75,000 kw.			75,000 kw.	
Units to Bus-bars	220,000,000			300,000,000	
Load Factor ..	33·5 per cent.			45·7 per cent.	
	Annual Cost.	Cost per unit.		Annual Cost.	Cost per unit.
	£	*d.*		£	*d.*
Fuel—					
2 lb. per unit at 12*s.* ..	117,857	·128	1·8 lbs. per unit at 12*s.*...	144,643	·115
Oil, &c.	1,000	·002		1,250	·002
Salaries and wages	16,500	·018		18,500	·014
Repairs	11,500	·012		12,500	·010
	146,857	·160		176,893	·141
Rates, taxes and management ..	17,000	·019		18,500	·015
Capital depreciation obsolescence at 10 per cent. ..	90,000	·098		90,000	·072
Total cost ..	253,857	·277		285,393	·228

We may observe, with reference to the allowance for capital charges, that it is certain that higher rates of interest will have to be paid in the future than were demanded before the war. On the other hand, obsolescence ought to be less rapid than in the past. No such revolutionary change as the replacement of the reciprocater by the steam turbine is to be expected in the immediate future, although no doubt there is a considerable field for improvement in boiler-house practice. It is true that even here there is little opening for much improvement in boiler efficiencies, since it appears that a year-in year-out figure of 82 per cent. to 83 per cent. has been actually realised at one large station on the North-East Coast. A reduction in the size of the boiler plant may, however, prove practicable and would considerably reduce land costs.

Mr. Watson considers that with such a station as he proposes the extra high tension current could be supplied at the bus-bars for an inclusive yearly charge of 2*l.* 2*s.* 6*d.* per kilowatt of maximum demand, plus 0·102*d.* per unit actually supplied. Owing to the diversity factor the maximum demands on the feeders will never coincide, and similarly, as each feeder has in its turn a diversity factor, the maximum demand on any particular feeder will always be less than the aggregate of the maximum demands of the customers supplied. Allowing for this, a yearly charge of 1*l.* 13*s.* 7*d.* per kilowatt of the maximum demanded by each customer, plus 0·102*d.* per unit supplied would cover the whole of the station costs. To these, however, must be added the cost of transmission. The high tension mains for the whole area would, if laid underground, cost about 660,000*l.* for the area under consideration, and would involve an annual charge of 66,000*l.* The actual cost of supplying any particular customer would thus vary with the distance from the power station, ranging from 2*s.* 6*d.* to 22*s.* 6*d.* per kilowatt of maximum demand, with an average of 12*s.* 6*d.* The actual cost of the extra high current supply will therefore be represented, Mr. Watson says, by the figures given in the next column.

Extra high-tension current can, however, be used directly by but few, if any, consumers, and must generally be transformed. If the distribution be effected on the low-tension alternating-current system the losses involved will bring up the total yearly cost of the extra high-tension supply to a minimum of 2*l.* 3*s.* 8*d.* per kilowatt, plus 0·110*d.* per unit supplied, whilst under less favourable conditions the figures may be as high as 3*l.* 14*s.* 1*d.* per kilowatt of maximum demand, plus 0·126*d.* per unit supplied.

——	(1) Cost Minimum.	(2) Cost Average.	(3) Cost Maximum.
	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
Kw. charge	1 13 7	1 13 7	1 13 7
Loss in mains ..	1 10 (5 per cent.)	3 8 (10 per cent.)	5 6 (15 per cent.)
Transmission.. ..	2 6	12 6	1 2 6
Cost per kw.	1 17 11	2 9 9	3 1 7
plus Charge per unit ..	·107*d.* (5 per cent.)	·112*d.* (10 per cent.)	·117*d.* (15 per cent.)

If the extra high-tension current has to be converted into direct current the losses are higher and the corresponding figures for this case become as a minimum 2*l.* 15*s.* 2*d.* per kilowatt of maximum demand, plus 0·118*d.* per unit supplied, and as a maximum 4*l.* 17*s.* 9*d.* per kilowatt plus 0·140*d.* per unit supplied.

One of the great difficulties which will have to be overcome in modernising our system of electric power distribution will be due to the resistance of vested interests. Mr. Watson's analysis of costs should prove of great service in abating the opposition thus arising. He shows that it will be economical for these relatively small power stations to take a bulk supply even when they generate and supply continuous current. By using their existing generating plant solely to take the peaks they can get their bulk supply on very favourable terms and substantially reduce their present operating costs.

Mr. Watson considers in detail the case of three such stations generating respectively 4,000,000, 10,000,000 and 17,000,000 units per annum. As low but possible costs he gives the following figures :—

	(*a*)		(*b*)		(*c*)	
Units supplied ..	4,000,000		10,000,000		17,000,000	
Maximum load ..	2,000 kw.		4,000 kw.		6,000 kw.	
Load factor.. ..	22·5 per cent.		28·5 per cent.		32·4 per cent.	
Capital outlay ..	£80,000.		£100,000		£130,000.	
Annual Costs :—	£	Per unit. *d.*	£	Per unit. *d.*	£	Per unit. *d.*
Fuel at 12*s.* ..	4,800	·29	8,100	·19	11,400	·16
Other expenses ..	5,600	·34	7,475	·18	9,225	·13
Capital Charges..	6,000	·36	10,000	·24	13,000	·18
	16,400	·99	25,573	·61	33,625	·47
Cost per kw. ..	£5 12*s.* 3*d.*		£4 6*s.* 9*d.*		£3 14*s.* 6*d.*	
Plus per unit ..	·310*d.*		·198*d.*		·150*d.*	

If instead of generating the whole of their current the existing generating plant was utilised for taking the peaks only, the annual costs would be as follows :—

——	Minimum.	Average.	Maximum.
	£	£	£
(*a*)	13,166	13,809	14,460
(*b*)	22,504	23,654	24,821
(*c*)	31,530	33,372	35,238

Only in the case of station (*c*) does local generation show to advantage, and this only when the bulk supply is taken at the maximum rate. Moreover, as extensions were made the opportunity could be taken of introducing low-tension alternating current in place of the direct current, and the cost of the bulk supply would be correspondingly reduced. Where no local power station already exists the case for the bulk supply is still stronger. Here, in most cases, there would be no necessity to distribute continuous current and the costs of conversion from alternating to direct current would be avoided. If a local station for 2,000 kw. maximum demand were put up generating and distributing continuous current, the annual cost would, Mr. Watson says, be 16,400*l.*, as against 6,200*l.*, the estimated cost of a low-tension alternating-current supply taken in bulk from a super-power station.

Mr. Watson calls attention to the advantage to be gained by using alternate current for distribution, and suggests that further extensions of continuous current networks should be discouraged.

The highly controverted question as to how the super-power stations are to be financed and

controlled was not touched upon by the speaker, but in the meantime it is of great significance that a leading municipal engineer should point out so fully and frankly the urgency of abandoning the mistaken policy of the past which deliberately aimed at a multiplication of electrical supply authorities and of systems of distribution.

NOTES.

Railway Accidents in 1917.

The Board of Trade returns for the year 1917 show a substantial diminution in the number of accidents on our railways, as compared either with the previous year, or with the average in normal conditions of working. During the year, 125 passengers, 382 railway servants, and 382 other persons were killed on the lines, and, in all, 4,208 were injured. In 1916, the number killed was 1,066, whilst the injured amounted to 5,589. For the decade 1906–1915 inclusive, the corresponding average figures were 1,184 killed and 29,368 injured. The number of fatal accidents was thus 285 below the average. Apparently, there is a very much more notable diminution in the number of non-fatal accidents, but it must be noted that the returns for these have been made up during the last two years on a different basis than formerly. The companies are not now required to report non-fatal accidents unconnected with the movements of trains. The returns are nevertheless remarkable, considering that traffic has been heavier than ever and has had to be conducted with a greatly diminished staff.

Neon Lamps.

Neon is a very curious gas, and very promising for the illuminating engineer. Although its atomic weight of 20·2 is intermediate between those of helium 4 and of argon 39·88, it has the lowest dielectric cohesion known of any gas, 5·6, while the dielectric cohesion of helium is 18·3 and that of air 435 (E. Bouty). Owing to this fact a very small electric potential suffices to set neon glowing; a glass tube containing neon need only be shaken to call forth the reddish glow, and when the gas is pumped from one vessel into another, the whole column shines. Its spectrum is most favourable for light effects, the chief lines lying in the yellow and orange-red between 530 $\mu\mu$ and 650 $\mu\mu$. When G. Claude, of Paris, therefore, succeeded in preparing neon, or at any rate, mixtures of neon and helium commercially by liquefying air, neon seemed to be the ideal gas for illumination by means of glass tubes, many feet in length, after the method of Moore, who charged his tubes with rarefied nitrogen. The potential gradient in the positive neon column is only 1 volt per centimetre in wide tubes (a few inches in diameter) and Claude found that, in neon at a pressure of 1 mm. or 2 mm. of mercury, the fall of potential is inversely proportional to the width of the tube, and that on tubes of large cross-section a very small potential would suffice to sustain the discharge. The neon in the higher atmosphere, he suggested, might also account for the luminosity of the aurora borealis; with the enormous available cross-sections of the atmosphere very small potential differences would maintain a discharge through distances of many miles. The neon-tube lamps of Claude indeed evoked a great interest some year ago.* Little has been heard of them of late, however. Their reddish light is against them, and though they were popular for advertisement purposes, their use did not spread. There are great technical difficulties, moreover. Traces of other gases in the neon suppress the glow, and as air will force its way into vacuum tubes, the lamps deteriorated. To a certain extent the lamp cures itself; Claude observed that the metallic electrodes of his tubes gradually absorbed helium so that finally only the neon spectrum was visible; this may help to explain the hotly-contested statement made by the late Sir W. Ramsay and Messrs. J. N. Collie and H. S. Patterson (1913), that neon appeared after long use in hydrogen discharge tubes; speculations as to a synthesis of neon were based upon those experiments. But most impurities interfere with the glow, and that applies also to the metallic vapours and gases given off by the electrodes. Claude worked first with high-tension alternating current of low intensity, about 1 ampere. On low-tension direct-current circuits the lamps are arranged like the Cooper-Hewitt mercury-arc lamps. The anode of the recent lamps of Skaupy and others is made of a metal of low volatility (iron, nickel, tungsten), the kathode of a liquid metal or an easily-liquefied metal, to which the arc adheres. The vapours of the kathode metal must not be allowed to penetrate into the neon, and they are condensed by cooling or by providing buffer plates; when metals like the alkalis, thallium or cadmium are used, there is danger, moreover, not only that the metals will be deposited on the glass walls, but also that they will attack the silicon in the glass. Mercury itself has been found to be unsuitable as kathode material by Claude and by Cooper-Hewitt. Skaupy tried sodium which has the advantage of absorbing the residual gases. Fritz Schröter, who showed his new lamps at the April meeting of the Bunsen Gesellschaft, in Berlin, first tried sodium amalgam, but later introduced an alloy of cadmium and thallium. He obtains one candle at an expenditure of about 0·27 watt, but the resistance—which may be an ordinary incandescence lamp—brings the current consumption up to 0·5 watt. The neon lamp is started with the aid of a self-induction coil. One advantage of the red rays is that they penetrate foggy air well.

* See Engineering, June 6, 1913, page 764.

Opening of the Rhône, Marseilles to Geneva, to International Traffic.

The harnessing of the Rhône in the vicinity of Bellegarde, situated about 10 miles from the Swiss frontier, and about 20 miles from the point of confluence of the Arve with the Rhône, the main object being the generating of current for the supply of Paris and other French cities, with electric light and power, was dealt with in a former article of ours (see Engineering, vol. lxxxiii, page 454). As we also stated, due consideration was given at the same time to the question of rendering navigation possible in the upper reaches of the river on French territory, as far as Geneva. A dam was to be constructed; the Bourget lake, to the south of the barrage, was to act as a regulator for navigation purposes, and boat lifts, or series of locks, were to be provided to enable lighters to travel up as far as Geneva. Since the date—1907—of our article, the scheme has been under consideration; the war has of late emphasised its importance, for France, principally from the point of view of power generation owing to coal shortage, and, for Switzerland, from that of providing a satisfactory means of transit to the Mediterranean. On French territory, between Geneva and below Bellegarde, the Rhône, the flow of which is there increased by the Arve, has a fall of about 70 m. (about 230 ft.); in the vicinity of Bellegarde, the river disappears almost entirely in clefts in the rock formation. The promoters of the scheme advocate the formation at Bellegarde of a reservoir 23 km. (14.3 miles) in length, having an area of 380 hectares (940 acres), and a capacity of 50,000,000 cub. m. (1,765,000,000 cub. ft.). The dam would have a total height of 103 m. (338 ft.), including the foundations; the height above the foundations would be 76 m. (250 ft.), and the depth of water at the dam, 67 m. (220 ft.). The total developed length of the dam is given as 150 m. (490 ft.), and its thickness at the base would be equal to its height. These various points, and the advantages to be derived by placing Geneva in direct communication with the maritime traffic of all nations, were referred to in a very interesting address which was delivered on the 13th inst., at Steinway Hall, by Mr. J. Vallotton, LL.D., Lausanne, the representative in Switzerland of the London group of the Nouvelle Société Helvétique, 28, Red Lion-square, Holborn, W.C.1, who stated that Switzerland was practically the only country in Europe absolutely blockaded. Hitherto the Rhine only had been used for navigation to and from Switzerland; the war had shown the absolute necessity of further transport facilities, and had caused renewed attention to be given to the advisability of establishing a new means of direct communication between that country and the trade of all nations. The scheme was not a new one, he added, and before the war—in 1912—the French Chamber of Commerce in Geneva had called attention to its importance. Navigation on the Rhône far above Lyons was already assured; what was needed was the regulation, briefly outlined above, as far as Switzerland; the work of regulation would take five years, and navigation for Swiss trade would be best assured by means of 600-ton boats. The average speed going down would be about 20 km. (12.4 statute miles) per hour, whilst the speed coming up from the Mediterranean would be about 6 km. (3·7 statute miles). Switzerland required raw materials, heavy and relatively cheap goods, and the latter speed would meet the case, whilst the higher speed travelling down to the sea would be a satisfactory speed for the delivery of goods of Swiss manufacture. The French railways had comparatively low tariffs at the present time, but an increase in their tariffs was to be anticipated after the war, by reason of the repairs which the railways would have to undergo, a fact which, from the point of view of both the Swiss manufacturers and the consumers of Swiss-manufactured goods, spoke in favour of transport by water between Switzerland and the Mediterranean. The fact that France had appointed a Franco-Swiss Commission to study the question of navigation on the Rhône as far as Geneva, showed that it was recognised as a vital question. The realisation of the scheme, besides benefiting Switzerland, would have for effect to bring back to Marseilles the traffic that belonged to it, a large portion of which had been diverted to other, north Continental ports.

Depreciation of Machinery and Income-Tax.

The result of the efforts of Mr. George Terrell, M.P., and the manufacturers' organisation is that a concession was made by the Government during the committee stage of the Finance Bill in the House of Commons. Mr. Bonar Law put down a new clause (24 in the Bill), and then moved seven amendments to his own proposal. These changes reflect the efforts of Mr. Terrell and his colleagues. The effect of the concession (it is no use quoting the clause till it appears in its reconstructed form on the third reading), is that the rate of 5 per cent. per annum on the written-down value may now be appealed against; the appeal being not only to the Commissioners of Inland Revenue, but to a Board of Referees. The appeal must be brought by "a considerable body of persons" in a particular trade or class of business, so that a general rate for machinery used by engineers may result from an appeal, which will certainly be brought. The 5 per cent. now allowed is not a recognised rate, but it is an almost invariable practice. The Board of Referees may "determine the deduction to be allowed," which means that their decision would be binding on the Income Tax Commissioners. The higher rate, if decided, would only be allowed if the value were actually written down in conformity with it. A further concession is made by providing for some allowance in the case of machinery temporarily thrown out of use during the war. It is obvious that such machinery depreciates in value, even if it rests idle, though not to the same extent as if it were in action. This obvious fact is now admitted by the Government, but only if the non-use of the particular machinery is "directly or indirectly" attributable to the "present war." A further proposal moved by Sir J. D. Rees, M.P., was admitted to be sound in principle, but was deferred by agreement till next year. It refers only to buildings, &c., not to machinery. At present one-sixth of the rack-rent is allowed annually for repairs and maintenance if the buildings are in this country, but not if they are abroad. An exception was formerly made in favour of mills, factories, &c., abroad, the profits of which were subject to income tax at home. The courts, in the Bowstead case, gave the allowance to the "abroad" property. The Government, by special enactment, restore the former practice, but not the exception in the case of mills, factories, &c. Only an allowance on mill and factory buildings is now claimed and will be considered next year. Of course, many engineering firms have workshops abroad which are practically part of their home plant, while all have been very hardly dealt with in the past by the Inland Revenue Department and the Income Tax Commissioners.

LITERATURE.

Irrigation Works Constructed by the United States Government. By ARTHUR POWELL DAVIS, Chief Engineer U.S. Reclamation Service. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. 1917. [Price 21*s.* net.]

THE official position of the author gives to this work an exceptional value. Having access to exact and extensive information, the statistics are trustworthy and conclusive, and his experience gained under very varied conditions enables him to speak as an irrigation expert. His object is to explain the work of the Reclamation Service, to show to what extent the arid and semi-arid lands of the West and Middle West of the United States have been converted into highly profitable farms, supporting an industrious population and enriching the Commonwealth. Writing as an engineer for engineers, he invites attention to the many novel and difficult problems that have been successfully encountered, but he does not entirely overlook the social and economic factors that are involved in the development of the benevolent scheme contemplated by the Reclamation Acts. Indeed, it would be difficult to exclude such topics, for though the construction of irrigation works must be primarily directed to the reclamation of lands rendered infertile by lack of moisture, yet with this clearly definite object several social problems are closely connected, as for instance, the relief of congestion in industrial centres by settling a very considerable population on land hitherto unutilised, the creation of a valuable class of citizen, and the extension of the home markets by the increase of both large consumers and producers. We hear much in these days of plans intended to promote settlement on unoccupied land. Those who advocate such schemes, the social reformer, the philanthropist and the politician, may listen with advantage to one who has seen both success and failure follow well-intentioned projects planned with deliberation, financed by Government, and directed by experience.

The Reclamation Act dates back to 1902 and is designed to effect the development of irrigation in certain of the States and territories of the Union, by employing the funds derived from the sale of public lands in projects, desirable in themselves but unattractive to private or corporate enterprise. The machinery provided ensures that the money so expended shall be returned to the fund by the repayment, without interest, by the persons who are directly benefited; the refunded money is used over and over again for the same purpose, constituting a revolving fund. This repayment is an admirable safeguard, requiring that each project undertaken must reasonably be considered worth what it costs. From unforeseen accident a plan may fail. The author quotes one such instance, the Hondo Project. The reservoir had to be constructed among extensive deposits of limestone and gypsum, and when brought into use considerable leakage occurred. The quantity increased by the enlargement of holes in the bottom of the basin, which evidently connected with subterranean caverns of great extent and capacity. This unfortunate result could not have been foreseen, at the beginning of the enterprise. Such cases are fortunately few and their occurrence does not affect the thorough business character of the whole plan. Another excellent provision is that the land should pass into the hands of small owners, men who live and work upon the land. The farms that are most successful and most intensively worked are those of 40 acres only, and the author regards the permission given by law to allow settlers to occupy land to the extent of 160 acres, as forming one of the most serious and far-reaching handicaps to the success of the scheme. The settlers eager for possession, but lacking experience and furnished with insufficient capital, rush on to the land before the irrigation scheme is in working order; sometimes before it is taken in hand. The consequence is they become impoverished, and are burdened the first few years with charges upon a large area of land, none of which they were able to cultivate properly owing to want of preparation and equipment.

The Government is aware of the evil but apparently unable to remedy it. The situation is further aggravated by the artful machinations of the land speculator, though the Government, by insisting on the residential qualification, has considerably reduced this evil influence. Yet the struggle between the department and the capitalist goes on unceasingly, and it is to be feared that the ingenuity of the land-grabber and the middleman in the end occasionally defeats the benevolent intentions of the Government. The construction of irrigation works increases the value of the land automatically, and this increase, or unearned increment, is unduly exploited. "If," says the author, "this increase of land value or any large fraction of it could be promptly returned to the Government through any legal process, it would afford a large profit on the investment . . . there appears to be no escape from the fact that the benefits of all public improvements, including irrigation works, inure to the benefits of the land owners, almost exclusively."

In judging of the financial position of the whole project on which over 100,000,000 dols. have been expended in the reclamation of some 1,500,000 acres, or an area about the size of Lincolnshire, it must be remembered that the Government laboured under a great disadvantage. They were late comers into this field of adventure. Private enterprise had seized upon the most eligible sites, where water could be most easily procured, and the bottom lands, most easily reached by gravity distribution from neighbouring rivers, were already covered by cheaply made canals, that secured water rights, thus preventing the prosecution of a thorough well-developed scheme without first buying out the early claimants. Even where irrigation work had not been attempted, the estate speculator had availed himself of the broad and generous water laws of the United States to lay claim to the great natural resources available for purposes of power development and water storage. In many instances, the Government has been compelled to buy back at heavy cost the valuable rights only recently given away. In fact, one of the chief arguments for the passage of the Reclamation Act was, that private enterprise had practically exhausted the field for investment, and that if the West was to be developed and homes made for a great population, it could be effected only by the Government taking up the task, keeping in view solely the indirect gain to the whole community—a gain, it was urged, that would far exceed any direct interest on the money invested.

This argument may be sound, but it is none the less to the advantage of the land speculator. As as instance of the manner in which hasty and premature enterprise handicapped Government undertakings, the Grand Valley Project may be quoted. The easily-accessible lands had been irrigated prior to 1902, and a prosperous fruit area had resulted. Subsequently a plan was proposed to construct a high-level canal through Utah. The scheme, as originally conceived, was found to be impracticable and was abandoned. Subsequently, in 1909, Government undertook a modified scheme. This involved the construction of a dam diverting the waters of Grand River into a canal on the north side The main conduit, for about 6½ miles through a canyon, consists of a series of tunnels and concrete-lined canals, crossing drainage by siphons or flumes until a tunnel 7,000 ft. in length emerges upon the valley. Owing to a less thorough scheme of irrigation having occupied this district, the route had to wind through adobe hills, reaching its first considerable area of new irrigable land after about 18 miles of heavy construction! Well may it be said that no large irrigation work has been financially successful, while small makeshift ditches built by farmers and settlers accomplish the work intended. This truth has become so well recognised, that it has become impossible to attract capital for comparatively easily completed schemes. There comes a time, however, when competition is so keen that small combination fails, and the author tells of such a case on the North Platte River, the waters of which were appropriated to such an extent, that in low-water years, during the late summer, the river was practically dry. In Nebraska more than 40 canals are diverted from the same river, with the consequence that in ordinary years most of them are short of water during the latter half of the irrigation season. Government intervention is not only necessary to promote extension, but to secure the results of the partial and ill-adapted works already in use.

Other instances in which Government assistance is beneficially exercised concern the prevention of destructive floods, which on low-lying flat lands may prove as great a hindrance to agricultural progress as insufficient moisture on arid plains. When irrigation water has to be supplied to a district, where frequent overflows are possible, a hydraulic problem of great interest is encountered. A typical instance occurs on the Orland Project, in California, where the lower part of the basin is very flat and over 1,000,000 acres are subject to flood. In this case the apparently incompatible relations of deficiency and excess of water in the same area were reconciled, by a system of levees and bye-passes, though the former are troublesome to maintain owing to the burrowing of animals, and the consequences of erosion on the banks, which may undermine a levee without even wetting the base. But it is impossible to enter into any details, either here or in the numerous cases where exceptional means have to be employed to meet local problems. It would be a great pleasure to tell of the construction of the Roosevelt Dam, and reservoir, that provides an area of 25 sq. miles, regulating the flow of the Salt River, or of the lofty Arrowrock dam connected with the Boise Project, as of many another triumph of engineering science, that has been brought to a successful issue by skill and perseverance. In this respect, Mr. Davis' work is especially encouraging and invigorating. In nearly every one of these schemes, whose history, purpose and operations are clearly set forth, some unexpected difficulty has to be met by ingenious stratagem, telling of expansive resource and ready expedient. Of necessity, each project had to be carried out in an area remote from the conveniences of mechanical industry. The management had often to house its own employees, manufacture materials from local sources, construct or adapt its own machinery and improvise its own power development. This last requirement had to be met in every case, where it was necessary to pump water to a higher level in order to serve districts that could not be reached by gravity. In some instances very considerable power plant was permanently installed and thoroughly equipped.

Owing to variety of soil and climate, of origin of source, and topographical conditions, each project called for individual treatment; there was no opportunity for copying or duplication of earlier projects, and this continual appeal to original methods gives a sustaining interest to Mr. Davis' pages. The illustrations are good and plentiful, and a particularly welcome feature is the summary of expenditure accompanying the description of each project. It is claimed that in the conduct of the work every reasonable safeguard was adopted to secure economy and efficiency in construction, and "that the engineers felt a professional and personal pride, in showing that they could and did execute these difficult operations in remote localities and under pioneer conditions not only well, but economically." This tribute to the staff is, we believe, fully deserved, and certainly the means for criticism are fully exhibited. We regret that the author has not been able to provide maps of the districts, showing the main topographical features and the outlines of the geology. To those unacquainted with American geography such maps would prove a boon.

Pyrometers and Pyrometry. A general discussion held by the Faraday Society. Reprinted from the Transactions of the Society, Vol. XIII., Part 3, May, 1918. London: The Faraday Society, 82, Victoria-street, S.W.1. [Price (including postage), 12*s.* 6*d.* net, in paper covers; 13*s.* 6*d.* net, in limp cloth covers.]

THE discussion on "Pyrometers and Pyrometry," which the Faraday Society held on November 7 last, excited so wide an interest, and called forth so many inquiries, that the council of the society very properly decided on the issue of a reprint of the whole discussion. The decision, it is not inappropriate to add, did not involve any financial risk, and the fact is a guarantee of the instructive and practical character of the information imparted, and of the general appreciation of instruments and

methods of measurements which, less than a dozen years ago, some technical men would have been ready to instal in their laboratories, but which very few of them would have consented to introduce into their foundries and shops. The discussion plainly shows that the technical man was not altogether to blame for hesitating to put expensive, delicate, frequently capricious, instruments into the hands of his men, who could not be expected to fidget about with apparatus, the handling of which was not properly explained to them, and the printed directions of which they could not understand, in substitution for their own eyes and simple tests, on which long experience had brought them to rely. But instrument makers and technologists understand one another better now, and the apparatus have been much improved. Glancing through the pages of this octavo volume of 170 pages, the reader will indeed find that authorities differ as usual. But there is agreement as to the main facts, and so many well-known men expressed similar opinions during the discussion, that the reader will be able to learn what certain instruments can do, and how they should be treated in taking measurements. Whether or not readings are reliable within two or three degrees, even at the high temperatures of steel furnaces, as some speakers claimed, is a minor matter.

We reported the discussion on pyrometers at some length in our issues of November 16 and 23, and need not enter into details on the present occasion. We must point out, however, that this reprint contains far more than we could then comment upon, not only because we had to study brevity and could not notice all the speakers, but also because some important contributions were only received after the meeting. Among these are a paper by Mr. Paul D. Foote, of the Bureau of Standards, Washington, on "The Relation of Optical and Radiation Pyrometry to Modern Physics," and Notes on "The Application of Optical Pyrometry in Steel-Works' Practice," by Mr. J. Neill Greenwood, the one as interesting theoretically as the other is practically. The full discussion also affords a good deal that is novel. We remember, for instance, that in connection with Mr. G. E. M. Stone's paper on "Causes of Unreliability Encountered in Thermo-electric Pyrometers, especially in Systems of the Base-Metal Type," we did not particularly point out that a similar study of noble-metals pyrometers would show them to be liable to similar imperfections. The point was obvious, but the further remarks on this question by Mr. W. Bowen and by Mr. C. E. Foster, and Mr. Stone's reply, deserve attention. While most authors and speakers have carefully revised their contributions, a few misprints have escaped notice in other papers under the actual stress of time; the misprints are quite harmless, however, and will not puzzle anybody. Sir Robert Hadfield has added a bibliography on pyrometers to the volume, which can be warmly recommended to all interested in exact temperature measurements, without which no branch of manufacture can hold its own in these days.

BOOKS RECEIVED.

Edible Oils and Fats. By C. AINSWORTH MITCHELL, B.A., F.I.C. London: Longmans, Green and Co. [Price 6s. 6d. net.]

Organic Compounds of Arsenic and Antimony. By GILBERT A. MORGAN, D.Sc., F.R.S. London: Longmans, Green and Co. [Price 16s. net.]

Cours de Geometrie, pure et Appliqué de l'Ecole Polytechnique. Par MAURICE D'OCAGNE. Tome II. *Cenematique Appliquée—Stereolomie—Statique Graphique—Calcul Grapho-Mecanique—Nomographie.* Paris: Gauthier-Villars et Cie. [Price 18 francs.]

Cours de Mecanique proferre a l'Ecole Polytechnique. Par LEON LECORUN. Tome III. Paris: Gauthier-Villars et Cie. [Price 25 francs.]

Labour Difficulties and Suggested Solutions; A Manual for Technical Students, Cashiers, Foremen, Departmental or Works Managers and Employers. By W. J. DEELEY, B.A. Manchester: Sheratt and Hughes. [Price 7s. 6d. net.]

Board of Trade Examination Calculations for First-Class Engineers. By PETER YOUNGSON, B.Sc.(Eng.) London, and JAMES H. SHAW. Glasgow: James Munro and Co., Limited. [Price 6s. net.]

A Handbook of Briquetting. By G. FRANKE. Translated by FRED. C. A. H. LANTSBERRY, M.Sc. Vol. II. *Briquetting of Ores, Metallurgical Products, Metal Swarf and Similar Materials, including Agglomeration.* With Appendices. London: Charles Griffin and Co., Limited. [Price 15s. net.]

INDUSTRIAL NOTES.

THE Director of the Department of Labour Statistics dealing in *The Labour Gazette* with the labour Market states that in May employment continued to be very good generally, and in many of the principal industries inadequate staffs worked much overtime. The restrictions imposed on the hours of labour in woollen and worsted factories were withdrawn on May 17, but in most of the textile industries employment continued to be affected by the regulation of the consumption of raw materials.

Trade Unions with a net membership of 1,090,348 excluding those serving with the Forces, reported 9,850 (or 0·9 per cent.) of their members as unemployed at the end of May, compared with 0·9 per cent. at the end of April, and 0·4 per cent. at the end of May, 1917. The increase in the percentage as compared with a year ago, was almost entirely due to the cotton industry.

Of the 3,797,223 male and female workpeople insured under the National Insurance Acts, 1911 to 1916, the number of unemployed at the end of May, was 33,079 or 0·87 per cent., compared with 0·96 per cent. in the previous month, and 0·67 per cent. a year ago. For males and females separately, the percentages unemployed at the end of May were 0·37 and 1·97.

The average weekly number of vacancies notified to all Employment Exchanges for the four weeks ended May 10, 1918, was 44,054, as compared with 38,222 in the previous five weeks, and with 39,536 in the four weeks ended May 11, 1917. The average weekly numbers of vacancies filled for the same periods was 33,898, 28,913, and 32,182 respectively. The number of workpeople remaining on the live register at May 10, 1918, was 30,468 men, 61,322 women, 8,229 boys, and 8,382 girls, a total of 108,401.

The changes in rates of wages (including war bonuses), reported to the Department as having been granted in May, resulted in a total increase of about 65,000*l.* per week in the wages of nearly 280,000 workpeople.

The principal increases were war advances to dock labourers at all the principal ports in Great Britain, amounting to 1*s.* 6*d.* per day at Liverpool, and to 2*d.* per hour at most of the other ports; increases of 10 per cent. to 35 per cent. on the piece-work prices of angle-iron smiths, platers, caulkers and riveters employed on Admiralty work by firms in Scotland, on the North-East coast, and at Hull, Barrow and Birkenhead. Increases were also reported in the building and printing trades, the linen industry, and the textile dyeing, finishing, &c., trades.

The number of disputes beginning in May was 71, and the total number of workpeople involved in all disputes in progress was 86,000, as compared with 19,100 in the previous month, and 237,200 in May, 1917.* The estimated total aggregate duration of all disputes during the month was 423,000 days, as compared with 128,300 days in April, 1918, and 1,855,000 days in May, 1917.*

The Minister of National Service desires to call attention again to the Order in Council under the Aliens Restriction Act, on the subject of the employment of aliens, which came into operation on March 1 last. Under this Order an employer must furnish to the Minister of National Service returns giving certain particulars with regard to any alien employed in one of the trades or occupations specified in the Fifth Schedule to the Aliens Restriction Order, and an alien must obtain permission from an Employment Exchange before he takes up any such employment.

Failure to comply with the Order is punishable by six months' imprisonment, or a fine of 100*l.*

Copies of the Order, including the Schedules showing the trades or occupations in question, and the returns to be made by employers may be obtained from any employment exchange, or from the Ministry of National Service, Victoria Street, S.W.1.

Employers may also obtain forms on which to make returns from the Ministry of National Service, or may use their own forms provided that the prescribed particulars are given.

The appeal of the Government to all skilled workers to become war munitions volunteers has already had a cordial response. Hundreds of men have enrolled during the past few days, and have thus declared themselves ready to be transferred to any essential war work to which they may be appointed in the national interest. Nothing could better illustrate the spirit of the workers as a whole, and their determination to carry the effort of the nation to its utmost limit in view of the crisis in the fortunes of war which the Allies have now to meet.

A great mobile army of labour is thus being created under conditions which will enable it to be constantly employed with the utmost economic advantage, and in a way that will meet any emergency that may arise.

A careful survey of the labour employed on essential war work is being made: and where, after investigation, responsible officers direct that workmen employed by any firm should be transferred elsewhere, such men, if not already enrolled as war munitions volunteers, are being asked to enrol or to satisfy the Local Enlistment Complaints Sub-Committee that such enrolment would involve great personal hardship, or that there are adequate reasons why they should not be transferred to a distance from their homes.

In the event of any workman refusing to enrol and the Enlistment Complaints Sub-Committee not supporting his refusal, the case will be reported to the Ministry of Munitions in order that the Department may consider whether sufficient justification exists for continuing his protection from military service, and with a view to making the safeguards already provided more complete, the Ministry has made a further proposal to the Trade Union Advisory Committee, *viz.*, to appoint a central sub-committee to advise on all cases so reported. Mr. Frank Smith, Chairman of the Trade Union Advisory Committee, has stated that in view of the expressed opinion of the members of the Committee at the conference last week, he feels sure a central sub-committee is desirable; and it is expected that within a few days practical effect will be given to the proposal of the Ministry.

The following are some recent decisions given by the Committee on Production on cases which have been referred to them by the Ministry of Labour, including cases arising out of the Orders under which a bonus to munition workers has been given:—1. *Aircraft Industry.*—Painters, polishers, dopers and upholsterers and semi-skilled and unskilled workers employed in establishments engaged in the manufacture and repair of aeroplanes and seaplanes, directly on such manufacture or repair, are to receive in the case of plain time workers, a bonus of 12½ per cent. on earnings, and, in the case of pieceworkers and men working at augmented time rates fixed in lieu of piece rates or by reference to results or to output of work, a bonus of 7½ per cent. on earnings (excluding travelling time, outworking or similar allowances) from the first pay in January, 1918. The men concerned employed in aircraft establishments (which expression includes any manufacturing establishment engaged wholly on the manufacture or repair of aeroplanes or seaplanes, or of components or parts thereof, or any workshops belonging to a composite establishment in which such work is exclusively carried on), are to receive an advance of 5*s.* a week from first pay in January, 1918, any advances given since November 1, 1917, to merge in the advance of 5*s.* a week now awarded. Having regard to the diversity which exists in respect of wages in establishments other than those indicated above, the Committee on Production make no general order as to an advance of wages to men employed on aircraft alongside other work in such other establishments. Any necessary adjustments required in these establishments are to be discussed by the parties concerned. 2. *Painters and Decorators, Sheffield and District.*—Plain time workers are to receive a bonus of 12½ per cent., and piece workers a bonus of 7½ per cent. on earnings from first pay after May 17, 1918. 3. *Brassfinishers, Edinburgh and Leith Corporations Gas Commissioners.*—Plain time workers are to receive a bonus of 12½ per cent. on earnings from first pay after January 1, 1918.

A fine piece of repair work has just been done by the men of the Mercantile Dry Dock Company, at Jarrow. A steamer which had been torpedoed on a Sunday afternoon, was brought into the Tyne on the following day and moored alongside the Mercantile Works. She had a rent in her side near the engine-room some 40 ft. in length. Her salving was in itself a smart feat. Early on Tuesday, the steamer was placed on the Admiralty pontoon at Jarrow Slake, and the Mercantile Company's men worked day and night until Friday, carrying out temporary repairs to enable her to be towed round to the Wear for completion. The Tyne was so busy with urgent work that the new comer could only be taken in hand for temporary repairs, which were effected so rapidly as, it is believed, to constitute a record for the river. Many of the men worked 43 hours at a stretch, and others put in four consecutive shifts without a break. They were warmly congratulated by the managing director, Mr. M. C. James.

The elderly men employed up and down the Tyne at shipyards and graving docks are setting a fine example in time-keeping to their younger mates. There is a joiner, 70 years of age, in the Mercantile Dry Docks Company's yard at Jarrow, who has not lost a quarter for nine years, whilst a blacksmith in the same yard, also 70 years of age, has not lost a quarter during the war. By "a quarter" is meant one of the working periods into which the shipyard day is

* The figures for 1917 have been revised in respect of the dispute in the engineering trades which occurred in May, 1917.

divided, and a man is said to "lose a quarter" when he is excluded from the yard for one such period by reason of his coming to work late. There are quite a considerable number of workmen between the ages of 50 and 60 who have not missed an hour since August, 1914. Unfortunately, there is a proportion of the younger men who are not stimulated to better time-keeping by the example of these older men.

Messrs. Harland and Wolff will probably soon break their own record of 30 weeks for completing an 8,000-ton oil-carrier. On Monday last, the plating was completed of a sister ship, which was fully framed on April 8. Compared with the nine weeks taken for this part of this oil-carrier's construction, the sister vessels preceding her had taken ten weeks and a day, 12 weeks and 16 weeks, respectively. The "shell" squad which have performed this admirable piece of work have, during the six years that Messrs. Harland and Wolff have owned the yard, fitted considerably over 15,000 shell plates, an average of 51 per week over the six years. The merit of this record will be the better realised when it is added that all the vessels were large ones.

Port Glasgow's eight large shipyards are doing valuable work in the production of merchant shipping. Messrs. Russell and Co. recently completed for the Brocklebank Line of Liverpool, a large first-class freighter of over 16,000 tons capacity, named the Malancha. A few days ago they launched a sister ship, the Macharda, which is now being engined in Glasgow by Messrs. D. Rowan and Co. She is 518 ft. long, 63 ft. 7 in. broad, and 35 ft. 4 in. deep, and has a gross tonnage of 10,572 tons. She will be able to carry nearly 17,000 tons of foodstuffs. A simple calculation shows that on every voyage she will bring enough food to give about 1 lb. to every man, woman and child in this country. The importance of expediting the output of such vessels is too obvious to need insisting upon.

Mr. G. Roberts, Minister of Labour, in moving in Parliament, on Monday last, the second reading of the Trade Boards Bill, said that great dislocation of industry would undoubtedly follow the war; it was particularly necessary, therefore, that rapidly-adjustable machinery should be available for setting up boards in certain industries. This applied with particular force to the case of women. Many groups of women during the war had been able to elevate wage conditions to a more reasonable standard than heretofore, and it would be extremely undesirable for them to lapse back into the conditions that prevailed before the war. There were other groups who had not, despite war conditions, been able to raise their status to anything which could be regarded as satisfactory. This made it more desirable that machinery be provided to adjust wages on a reasonable basis, and more in accord with the spirit of the times. The Bill gave power to the Ministry of Labour to set up Boards by special orders, after giving proper opportunity for inquiry and objections. The existing machinery was cumbersome, necessitating the introduction of a Provisional Order Bill whenever it was desired to bring a new trade under the Act. Moreover, if the Provisional Order Confirmation Bill was opposed, it was necessary for an inquiry by a Select Committee of the House to take place, involving great expense and considerable delay. This procedure, with its delays and safeguards, was probably justifiable when Trade Boards were in their experimental stage, but now that they were proved to be a valuable part of our industrial organisation, it appeared reasonable that a speedier method be adopted. After the war, imperial and domestic questions would emerge with great rapidity, and it seemed desirable, wherever possible, to delegate to responsible bodies matters which would otherwise occupy Parliamentary time.

Mr. Roberts then explained the working of the various clauses. The Bill was discussed at the sitting, and in the course of his remarks, Mr. Bridgeman, Parliamentary Secretary, Ministry of Labour, defended the proposal to proceed by special order instead of by provisional order, adding that it would save time and simplify procedure. He denied that the Bill, as some speakers had contended, gave enormous bureaucratic powers to the Ministry of Labour. The Bill was concerned more with women than with men. Large numbers of women now at work would be unemployed after the war. The task of transferring them to other industries would be one of the most difficult problems Government would have to face. It was also likely that the effect of large bodies of women seeking work after the war would be to encourage sweating in certain trades, mainly run by women. The Bill was designed to meet that situation. It would apply to badly-organised trades as well as to trades in which exceptionally low wages were paid. By first bringing such industries under Trade Boards, it was hoped to prepare them for the Joint Industrial Councils. The work of reconstruction after the war should be started with each trade organised to the fullest possible extent and animated by the best possible spirit and contentment.

The Bill was read a second time without a division.

Messrs. The Davis Gas Stove Company, Limited, Diamond Foundry, Luton, Beds., have established, in connection with their works, a training school, the object of which is to provide boys with a thorough theoretical and practical training in all branches of iron founding. The period of training is four years. Boys admitted to the school pass a probationary period, the length of which depends upon the ability shown by each individual boy. After that period, the boy enters the training section of the foundry proper, and starts under actual working conditions, his parents agreeing that he will not be removed—except under certain conditions—until the course is completed. Every boy undertaking the course is expected, in his own time, to attend certain technical classes at the direction of the firm, at least twice a week. During the probationary period, the hours are from 8 a.m. to 12.30 p.m., and from 2 to 4.30 p.m.; Saturdays from 8 a.m. to noon. After the probationary period, the hours are those of the foundry. In addition to their ordinary wages, "merit wages" are paid from time to time to all boys who show more than average ability, but no boy is eligible to the latter who has not a good record for general behaviour, time-keeping and tidiness. Examinations in the theory and practice of ironfounding are held at the end of every quarter. Prizes are given at the end of July each year to the boys who, in order of merit, have obtained the best aggregate results at the end of the four previous quarterly examinations.

A letter has been addressed by the Controller of Coal Mines to the Secretary of the Miners' Federation of Great Britain. The letter, after referring to the 400,000 men who have already left the mining industry to join the Colours, appeals to their comrades still at the collieries to play their part in the struggle for peace and freedom in which the nation is engaged.

More and cleaner coal is needed for domestic consumption, for essential industries at home and for our Allies. Recent military operations have increased the demand upon us for coal for France, and it is only on account of the urgency of these demands that the Government decided to suspend the recruiting of miners after only 25,000 of the second quota of 50,000, which it was intended to take from the mines, had been obtained.

It is not proposed to ask the miners to increase the length of their shift, because the Controller is convinced that by increased effort and improved attendance, the necessary output can be obtained. An increase of 10 cwts. in the weekly output of each coal-getter would result in an increase in the national output of about 10,000,000 tons a year.

The Controller asks that voluntary "absenteeism," which is the negative of community of sacrifice, should come to an end, and that the serious loss of output which has been brought about by sporadic strikes over disputes which could have been arranged without resort to this weapon, may cease.

INSTITUTE OF METALS.—The annual autumn meeting of the Institute of Metals will be held in London on September 11, when several important papers will be presented for discussion. A ballot for the election of members will be held on July 17, as a result of which the membership is expected to be brought well beyond the 1,000 mark—and that within the first decade of the Institute's existence. In connection with the ballot there has just been prepared for circulation to possible members an attractive new membership booklet. It contains a detailed statement of the Institute's varied activities, as well as numerous expressions of opinion regarding the value of the work accomplished and in progress. The latter have been contributed by many well-known engineers and metallurgists. Copies can be obtained from Mr. G. Shaw Scott, M.Sc., 36, Victoria-street, S.W.1.

THE LATE MR. JOHN H. HECK.—We regret to announce the death, which occurred last Sunday, at Newbiggin-on-Sea, where he was spending a holiday, of Mr. John H. Heck, senior engineer surveyor to Lloyd's Register of Shipping in the Glasgow district. Mr. Heck was 67 years of age. He was trained as an engineer at Woolwich, and entered the service of Lloyd's Register in December, 1882, when he joined the London staff. He was transferred to Newcastle in 1883, to Aberdeen in 1885, to Newport (Mon.) in 1889, back to Newcastle as senior in 1895, and to Glasgow as senior early in 1909 on the retirement of Mr. James Mollison. He was an enthusiast in his profession, and spent most of his spare time in engineering study and research. Mr. Heck has read many papers on engineering subjects before the Institution of Naval Architects, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, and other technical societies. He was well known and very highly respected among engineers and shipbuilders, both for his professional ability and his personal character.

THE OPTICAL SOCIETY.

AT a meeting of the Optical Society, held at the Imperial College of Science on June 13, the president, Professor F. J. Cheshire, O.B.E., in the chair, three communications were presented and discussed:—

"*A Chart for finding the Number of Lenses in, and Size of, a Block*," by Horace Lee, B.A. The chart shows by two series of intersecting curves the number of lenses it is possible to place in any ring of a block (up to 10 rings) when the maximum diameter of the block, the diameter of the lens, and the radius of curvature to which the lenses are to be worked are given. Any case likely to arise in the workshop can be at once determined by interpolation between the curves shown. The diagrams exhibited are for the two cases when the first ring contains one lens and three lenses respectively. The formulae from which the charts were calculated are given.

"*The Prevention of Filming in Enclosed Optical Instruments*," by H. S. Ryland. The principal points to which the author drew attention were:—1. That the filming is independent of the nature of the glass; 2. That the film itself is always alkaline; 3. That it is progressive; 4. That it is avoided by absolute cleanliness during the assembling of the instrument, by taking care that no soap or animal matter is left upon the glass surfaces, and that no volatile as water-bearing material is used inside an enclosed instrument.

"*Charts for Assisting in the Selection of Suitable Glasses for Cemented Doublets*," by T. Smith, B.A. Use is made of two charts sliding one over another in the manner in which a slide-rule is used, one of the charts being transparent. A single variable suffices to determine very approximately the numerical relation between the various spherical aberrations for all cemented doublets made from two given glasses. Chart No. 1 contains curves corresponding to constant values of this variable, the independent variables being the difference in the refractive indices of the two glasses and the logarithmic difference of their powers. The second chart consists of points defining the available types of glass, the scale in one direction varying with the type of chromatic correction desired. The glasses are selected by superposing one chart on the other, and finding two representative points on No. 2, which satisfy the condition that one point lies on the curve of No. 1, corresponding to the required type of spherical correction when the other point is on the origin of chart No. 1.

COPPER CASTINGS.—G. F. Cornstork having recently, before the American Electro-chemical Society, recommended the use of zinc and silicon as deoxidisers in the production of copper and bronze castings, Dr. W. R. Hodgkinson, in the Journal of the Society of Chemical Industry, May 30, 1918, calls attention to the valuable properties of calcium carbide for this purpose. The carbide is mixed with salt or borax in the proportion of 1 part of carbide to 2 parts of borax; the borax forms a flux which takes up any sulphide present. The carbide is a very efficient agent for the reduction of cuprous oxide, and is said not to introduce carbon into the copper or into the brass and bronze, and not to interfere with the electric conductivity of the metal and alloys. In the case of copper-nickel alloys, however, carbon might be taken up.

STANDARDISATION OF MILLING CUTTERS AND SMALL TOOLS.—The British Engineering Standards Association (by which name the Engineering Standards Committee will, in future, be known), at the request of a large number of manufacturers, who have felt that lack of standardisation has hampered production and retarded progress, has recently formed a representative sub-committee to deal with the standardisation of milling cutters and small tools. The work coming properly within the scope of Colonel Crompton's Sectional Committee on Machine Parts, he presided at a conference, at which the principal firms and associations interested, both makers and users, were present. Representatives were also present from the Ministry of Munitions Small Tools Department and, Woolwich Arsenal. The subject was fully discussed, with the result that the meeting was unanimously in favour of standardisation being undertaken. The sub-committee is under the chairmanship of Mr. R. Dumas, of the British Thomson-Houston Company, and a number of panel committees have been nominated to undertake the detailed study of the subject, as follows:—Panel I, Form relieved cutters; Panel II., Non-relieved cutters; Panel III, End mills; Panel IV., Reamers. On account of the pressure under which the industry is working at the present time, the committee have decided, in order to save the time of the members, that the work shall be carried out by these panels at convenient centres, those selected being Birmingham, Leicester, Manchester and Sheffield. The detailed reports of the various panels will be considered by the sub-committee sitting as a whole. In view also of the large amount of American machinery in the country, it is hoped to establish close and direct co-operation with American engineers and manufacturers through the American Society of Mechanical Engineers; Continental practice will, doubtless, also be taken account of. It is quite realised that the work being undertaken, important as it is, will be largely in the nature of re-construction work, and that the standards arrived at can only be introduced gradually on account of the amount of machinery already installed; yet, on all sides, expression has been given to the desire for such standards to be formulated without further delay, in order that gradually, the present unsatisfactory position may be effectually ameliorated.

TRADE AFTER THE WAR.

ENGINEERING.

THE report of the departmental committee appointed by the Board of Trade to consider the position of the engineering trades after the war, has just been printed in full. Some of the leading recommendations appeared in advance, in Lord Balfour of Burleigh's report, and were discussed in our leading article of May 3 last. The committee consists of Sir Clarendon G. Hyde, Sir Hallewell Rogers, Sir H. B. Rowell, and Messrs. A. Balfour, A. J. Hobson, W. B. Lang, and Douglas Vickers, all of whom sign the report. Mr. A. F. Ilsley acted as secretary. The findings of the committee, briefly, are :—

Production.—The statistics of imports and exports and the 1907 census of production were reviewed in order to survey the progress of engineering before the war. The exports showed a considerable increase. Including machines of all kinds and parts, but not including materials, the total exports were—

	£
1903	29,263,000
1907	48,140,000
1913	59,150,000

A number of tables are given, showing the destinations of these exports, and comparisons with similar exports of competing countries. The committee find, however, that there are no statistics which show the progress of engineering work as a whole and periodically in the form of returns of production, power available in factories, value of machinery, &c. The census of production states the value of the annual output at 168,500,000*l.* gross, or, excluding duplication and materials, 84,000,000*l.* net. The committee considered the figures, and estimated the real net production at 144,000,000*l.* annually. The employees in the engineering trades were :—

	Men.	Women.
Average, 1907	787,000	33,000
July, 1914	812,000	52,000
October, 1916	918,000	233,000

The committee regret that the classification of imports and exports in the Board of Trade returns is defective as it includes too many unclassified articles, and lacks uniformity with Dominion classifications.

Munition Work.—No figures of "national" factory production were obtainable. The machinery bought early in the war was too light, and much of the plant, even the heavier machines, will soon be worn and out of repair. It was not known whether the Government intended to use the plants after the war, or lay them up or dismantle them. The controlled firms have benefitted by getting supplies of materials and consideration for extra wear and tear of plant, but, on the other hand, their usual work and plant has been upset, and wages unduly interfered with by the authorities. The control should be removed as soon as possible after the war, but with regard and allowance to a period of re-settlement to normal conditions.

New Competition.—Canada and Japan have established especially large engineering plants, and will be formidable competitors in future.

Works and Plant.—Generally, works were on a smaller scale than in the United States of America and Germany. The plants were overvalued ; the small income-tax allowance for depreciation discouraged the writing down of the values. Foreign competing plants were more highly specialised than ours, the late-comers having selected special manufacturing branches.

Materials and Tools.—Large foreign purchases were made before the war, but not to the extent of making our firms dependent on foreign supplies, except in certain items. Practically all supplies can be produced at home, if unfair competition by differential prices or "dumping" is checked. Essential, but not all, materials can be produced within the Empire. The cycle trade is the best example of "component specialist" manufacture.

Methods.—Specialisation of output, with special selling arrangements, gives an advantage to foreign competitors. The small manufacturer will tend to disappear in this country. The "efficiency engineer," as a consulting adviser on particular work, should be encouraged. Costing should be further developed, but it may be overdone in elaboration. Standardisation should be carried further, especially in locomotives, machine tools and foundry work. The Engineering Standards Committee has done notably good work and should be encouraged.

Labour.—It was decided to consider both employer and employee sides, but the appointment of a special committee, Mr. Whitley's, on the labour question, practically restricted this committee to the employers' point of view. Employers generally agree that in skill, initiative and adaptability, the British mechanic is second to none. They complain mainly of (1) restriction of output, and (2) classifying work as skilled which is, in fact, unskilled. The complaints are well founded, and these practices may become of even more serious disadvantage to trade after the war. The workmen are actuated by mistaken, but not entirely selfish, motives. A statutory minimum district rate of wages for older and less-experienced workmen, should be considered. Piece or bonus systems should be encouraged, but the idea that time and a third is the maximum to which the worker should restrict his output, or at which the rate should be revised by the employer, should be abandoned. Adequate provision for taking meals, rest and recreation and proper housing are matters for action by the local and national Government authorities, as well as the employer. Apprenticeship, without premium and with fair wages, should be encouraged, with technical education in selected cases, say, one-third of the total boys.

Female Labour.—Women will probably not be permanently employed in engineering works, and many will leave as soon as the war is over. Those who wish to remain should have a right to do so. On light repetition work they are as good as men, and not restless for a change of work, as boys are.

Higher Education.—University graduates are too poorly paid in their earlier years, reaping no monetary advantage till they are over thirty. The committee strongly recommend better payment, encouragement of post-graduate courses and co-operation between universities and manufacturers in promoting scientific research.

Trade After the War.—The committee expect a large demand from abroad as soon as war is over, and, providing a certain proportion of the output is allotted specially to France and Belgium, recommend the withdrawal of the war restrictions on export trade generally as soon after the war as possible. Prices are likely to remain high for some time, and the supply of materials insufficient. Competition with Germany in neutral markets will be severe, especially as wages in Germany will probably fall, while a high rate is likely to be maintained in this country. High wages can be paid in this country if restriction of output is abolished and general conditions are favourable.

General Tariffs.—The committee were unable to agree on the general principle of protective tariffs, and prefer to make no recommendation, except on particular measures, which are chiefly of a transitory nature.

Proposals.—The recommendations which amount to specific proposals, are as follows :—

1. Prohibition of imports of engineering products from enemy countries for one year after the war, or longer if expedient.
2. A sur-tax, in addition to normal duties, to be levied by all Allied countries against enemy-country products ; the sur-tax to be gradually decreasing over a number of years. This country to impose a duty equal to the sur-tax.
3. Free import of raw materials.
4. Protection of "essential" industries.
5. Prohibition of "dumping" (accepting the American definition of the term).
6. Income-tax allowance for actual depreciation of machinery to be allowed up to 15 per cent., and a reasonable rate on buildings.
7. Age for leaving school to be raised to 15 years.
8. Compulsory education during apprenticeship at day classes, numbers to be limited to about one-third, and employers to pay wages for school time.
9. Hiring machinery on lease (as in the boot-making trade) to be legally regulated.
10. The terms of all trade combinations, both employer and employed, to be registered at the Board of Trade.
11. All Consuls to be British, and employed full time ; Vice-Consuls preferably British.
12. A new Commerce and Industry Department of the Board of Trade to be created.
13. More effective tariff preference with India and Dominions, and uniformity of customs declarations and classification of imports and exports.
14. Patents to last 15 years, with uniform patent and trade mark laws and fees within the Empire. Government revision of royalties on foreign-owned patents. Onus of proof that a foreign-owned patent is being worked to rest with the patentee.
15. All foreign imports to be marked "Not British."
16. British shipowners to be prohibited from "conference" arrangements with present enemies for three years after the war. Afterwards the terms of such arrangements to be registered at the Board of Trade.
17. Summer-time law to be made permanent.

In addition, there are, as indicated, various recommendations of an important nature, but not definitely proposed for legal enactment.

The report is dealt with in our leading article this week.

IRON AND STEEL.

A very definite policy has been arrived at in the majority recommendations of the Departmental Committee appointed by the Board of Trade to consider the position and after-war policy of the iron and steel trades. The minority is strongly opposed to the essential features of this policy, especially to the protective clauses ; but, in the result, the report is free from ambiguity, and will provide engineering opinion with a coherent issue for discussion. The committee consisted of Sir Hugh Bell and Messrs. G. Scoby-Smith (chairman), John E. Davison, James Gavin, John Hodge, M.P., John King, George Mure Ritchie, Henry Summers and Benjamin Talbot. Mr. Archibald Colville also served on the committee for four or five months, and signed the first interim report. The committee express great regret at Mr. Colville's death, which occurred in December, 1916. Mr. C. Roland Woods acted as secretary. The date of the final report is June 13, 1917, but it was only published in full on June 14, 1918. The specific recommendations may be summarised as follows :—

Tariffs.—During the reconstruction period importation of all enemy iron and steel products, and exportation of raw materials to enemy countries to be prohibited. Ores and minerals to be admitted free, and other materials only in unworked condition. Permanent tariffs scaled as maximum, general and minimum, to be fixed for all imported iron and steel and manufactures thereof, with specific duty on each class, variable readily in accordance with the national interest. A co-ordinated economic policy to be arranged for the Empire, and a law against "dumping" on the Canadian model, to be passed.

National Commercial Policy.—All imported iron and steel to bear marks of origin. Foreign syndicate representatives to be licensed. Shipping lines giving unfair freight preferences to be refused bunker fuel at Empire stations. Independent Ministry of Commerce department to be inaugurated, with advisory councils for each industry, and the control of Consuls and commercial intelligence. Loans raised for foreign interests to involve the purchase of home material, as far as possible. National and local government departments and railways to buy only British iron and steel. Income tax allowance for depreciation to be increased to accord with an efficient working life of plant. Board of Trade statistical returns to be revised.

Education.—School age to be raised to 16 years. Apprenticeships to be encouraged, to begin at 14, with attendance at continuation school to 16, employers paying an apprenticeship wage. Apprenticeship term to be seven years in heavy trades, with attendance at technical classes from 16 to 18 years of age.

Labour.—A single trade union to be introduced for the iron and steel trades with agreements extended to unskilled labour. "Agreement" differences to be settled by arbitration, with money penalties for deliberate breach of agreement, employer and employed association being responsible for their individual members. The distribution of labour and the restriction of output to be under the advice of a committee of managers, foremen and workmen in each works. An eight-hours' day to be followed in works running continuously.

Material.—The import and distribution of iron ore to be managed by an organisation of iron-ore users, who would acquire interests in ore properties abroad, receiving Government financial assistance, if necessary. Mining concessions within the Empire not to be granted to alien persons or companies without Government sanction. Adequate economic surveys of natural ore resources in the Empire to be made. Coking-coal owners and iron and steel makers to work together. Royalties and wayleaves to be settled by arbitration courts composed of mineral and surface owners, lessees of mineral and labour organisations.

Production.—British iron and steel manufacturers to combine specially to lay down large units of new plant for cheap production. Government financial assistance to be given in view of the high prices artificially created by war conditions, and the danger of a fall in prices depreciating capital values. British engineers to accept material which complies with the B.E.S. specifications. A committee of manufacturers, engineers and users to revise and reduce the number of sizes and weights of sections used in shipbuilding, bridges and structural engineering.

Transport.—During the reconstruction period, British ships not to carry raw materials or manufactured iron and steel from neutral ports to enemy ports ; Government to consider whether present enemy ships should be allowed to carry goods to or from ports in the Empire, or to coal at any Empire station. A court to be set up to investigate railway rates, comparing internal and through foreign rates, and to fix rates. A local court to investigate the North Staffordshire railway circumstances, and recommend immediate action. Shipping freight charges to be equal inward and outward. The division between railway and shipping companies, of the through rates on imported goods to be declared and a surcharge made equal to any rate preference given to imports. Government to consider the question of withholding Empire bunkering facilities from shipping lines giving preferential rates unfair to British goods.

Selling Arrangements.—A national association to organise marketing of British iron and steel products, and to distribute orders so as to reduce the cost of production by keeping individual works running economically on standard products. The export trade to be managed by a common selling organisation, representing all British manufacturers. These to be formed by a consolidation of existing associations into a company limited by shares, and meeting under the auspices of the Board of Trade.

Saving Clause.—The committee recognise that particular exceptions might have to be made in carrying out some of their proposals, but recommend that such exceptions should only be made by licence and in consultation with a fully-representative committee of the iron and steel industries.

The report contains much valuable information about production, imports and exports, and freight charges.

PERSONAL.—We are informed that Mr. R. W. Willis A.M.I.E.E., electrical engineer on the staff of the Director of Electrical Engineering, Admiralty, has been appointed to represent the Director in Manchester in regard to work in progress in the north-west area of England.—Messrs. Charles Churchill and Co., Limited, 9 to 15, Leonard-street, Finsbury, E.C.2, inform us that they have been appointed distributing agents for the well-known files manufactured by Messrs. Thos. Firth and Sons, Limited, Sheffield.

ULTRAFILTER.—In many analyses, especially in acid determination by the inversion of sugar, rapid filtration of turbid liquids is necessary. Such liquids are, however, apt to pass turbid through ordinary filter paper. In the *Chemiker Zeitung*, of April 17, 1918, Dr. Wolfgang Potwald describes how an ordinary filter can very simply be converted into an ultra-filter with the aid of some 4 per cent. collodion solution. The filter is placed in the funnel and wetted with water so as to lie well against the glass ; the collodion is thus poured into the filter. As the collodion is insoluble in water, it turns into an emulsion which soaks into the paper ; the collodion solution is filtered, and the paper allowed to dry. After five minutes the process is repeated. The filter is now stiff ; it is taken out of the funnel, placed on distilled water to coagulate the collodion, and is afterwards ready for use. As a rule, only the small filter cone which is fitted into the lower part of the funnel, need be treated in this way.

BLAST-FURNACE BEARS.*

By DR. J. E. STEAD, F.R.S., Vice-President.

(*Continued from page 662.*)

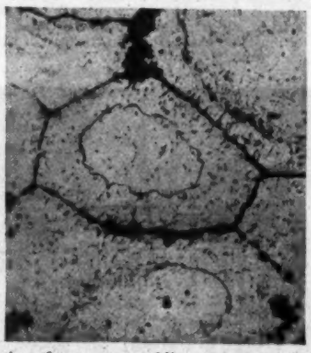
SECTION VI.

Oxides and Silicates of Iron.—The last things one would expect to find in the hearths of blast furnaces are oxides of iron or material closely resembling the mill cinder which runs from the beds of reheating furnaces. Yet, it is common to find these present, and in addition evidence of oxidising agencies. As examples two specimens which in appearance resembled mill cinder are selected; the first was very dense, and was free from any metallic particles of iron, while the second was associated with free metallic iron. Both specimens were found attached to the outer lower portion of the bear from No. 3 Ormesby furnace. Analyses of these are as follow:—

	No. 1. Per Cent.	No 2. Per Cent.
Ferrous oxide	51·30	81·5
Ferric oxide	6·07	11·5
Silica	20·50	5·0
Alumina	7·35	
Manganese oxide	11·50	
Lime	traces	
Magnesia	traces	
Sulphur	0·85	2·0
Phosphoric acid	1·43	
Other constituents by difference	1·00	
	100·00	100·0
Metallic iron	44·60	71·3

No. 1 analysis disposes of the hypothesis that unreduced ore is the source of the oxides of iron present, for the ore contains about 7 per cent lime and magnesia, and these are practically absent. What it does point to is that the oxides have been produced by oxidation of iron in the hearth itself, and that these oxides have reacted on and fluxed a portion of the brickwork. The very high proportion of oxides in No. 2 sample has obviously been derived from the metal, and not from unreduced ore.

Some of the portions of bears with columnar formation (see Section VIII) were found to be coated with iron scale, and the carbonless iron referred to on page 706 is evidence of oxidising agencies, for carbonless iron could not be produced above the twyer level, and what passed down below the hearth must have contained at least 3 per cent. carbon. The furnace from which the specimens referred to were obtained had always been fed with the ironstone from the Cleveland Hills, and for a short period with a small admixture of Gellivare ore, and the iron produced was practically all grey in fracture and contained about 1¼ per cent. phosphorus. It is difficult to prove definitely how oxides of iron could find their way below the hearth level, or how the carburised iron, after it arrived there, became oxidised and decarburised. The following suggestions have been made, viz., That portions of the unreduced ore, at some time during irregular working of the furnace, passed below the twyers and were forced under the surface of the liquid bear and retained there. There is some little reason for this assumption, for occasionally there has been found a more or less solid column in the central axis of the material in the hearth facing the twyers, as was proved by passing bars through the twyers and the hearth, for the bars could not be forced through the centre of the mass. Of course, no one has ever found what the obstructions really consisted of; it may have been unreduced oxides, but whatever it was it might have been forced downwards into the liquid iron below the hearth level. It is, however, difficult to conceive that it could have been unreduced oxide, for reduction, mainly to the metallic state, occurs well above the boshes, and it seems more probable that it was reduced and not carburised iron that constituted a part at least of the solid obstructions. Further, if any unreduced iron were to be forced into the liquid iron one would expect it would soon be reduced by the silicon and carbon of the iron itself. The most probable source of oxidation, however, is steam from the bricks and soil round the base of the furnace. A very little water vapour continually acting for many years on the external parts of the metal would in course of time be very material in its effect.



No. 5.—Section of a mass resembling a compressed puddled ball. White=Almost pure iron. Dark=Oxides of iron ×50.

No. 7.—Crystalline decarburised iron from a Cleveland bear. The flat bright parts are cleavages in the ferrite. Natural size.

One large lump from the exterior part of the bear from No. 3 furnace supported the latter hypothesis just advanced. It consisted of a mixture of magnetic oxide of iron and free iron, but the exterior parts were entirely oxides, while the central parts contained about 86 per cent. metallic and 14 per cent. oxides. The analyses of each gave the following results:—

	Oxides. Per Cent.	Metal separated by Pounding and Sieving. Per Cent.
Ferrous oxide ...	81·5	3·4
Ferric oxide ...	11·5	
Metallic iron ...	71·3	96·4
		100·0

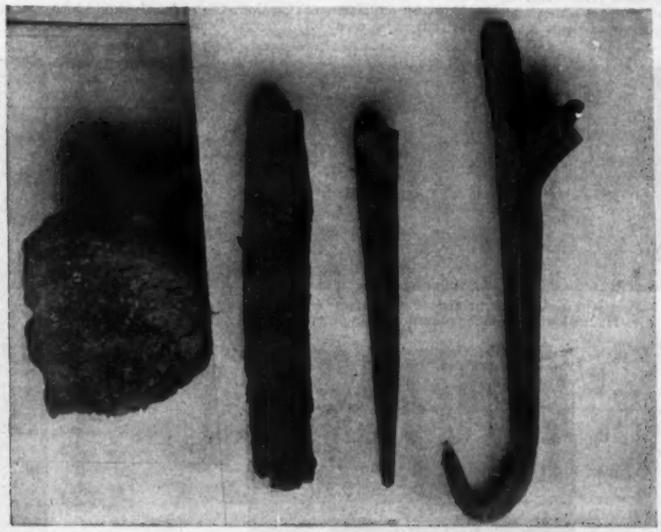
Had the mass been derived from partially reduced ore one would have had a preponderance of the oxide in the centre, and not at the exterior of the mass, therefore one must conclude that oxidation occurred in the hearth itself. The fact that the oxides and silicates found in the hearth of furnaces making Cleveland pig-iron are practically free from lime and magnesia, whilst the Cleveland ironstone contains considerable quantities of these bodies, disposes absolutely of the hypothesis that in the Cleveland district at least the oxides in the hearth have been derived from unreduced mineral. The analysis of the metallic part is interesting, as it shows a complete absence of carbon and only a small percentage of phosphorus, much less than was present in the class of iron the furnace had always produced.

The fracture of the mass corresponded closely with that of a slightly consolidated puddled ball from a puddling furnace, namely, grains of iron surrounded by cinder, and the analysis of the separated metal resembled that of the iron in some puddled balls after separating the cinder. There is, therefore, good ground for believing that the reactions in the neighbourhood where the specimen was found were similar to those in the puddling furnace and were of an intensely oxidising character.

The grains of iron which stick together in a puddled ball are not of homogeneous composition, for the central portions of many of the grains are more impure than the external parts where they are in contact with the cinder. The same peculiarity marks the grains in the specimen under consideration, for on etching polished sections with alcoholic cupric reagents, copper did not deposit on the nuclei as soon as it did on the parts juxtaposed with the cinder, which is an indication that phosphorus is higher in the central parts of the grains. The photomicrograph No. 5 of this section after polishing, but without etching, is full of interest; it suggests somewhat clearly that progress of the purification has proceeded from the outer to the central part of the grains. Assuming that the iron which at first reached the oxidising region approximated to that of normal Cleveland iron, the oxide formed would first attach the silicon and manganese, removing them completely, together with a portion of the phosphorus. As more oxide was produced, this, together with the phospho-silicates at first formed, would then attack the carbon, and the metal would "boil" as the carbonic oxide was formed and escaped, and eventually would solidify and granulate just as iron does in the hearth of a puddling furnace, but owing to the superincumbent pressure all the gases would be expelled while the grains of iron and intervening cinder would be closely pressed together. The heat being maintained, the further purification would be continued by a process akin to cementation, the oxide would attack the phosphorus and carbon as they diffused towards the outer portions of the grains. The carbon, owing to its more diffusive habit, would be the first to be completely removed, while the phosphorus, diffusing less rapidly, would slowly follow. The rounded black spots in the photograph represent globularised oxide of iron. The centre of the grains in the middle of the photograph is nearly clear of oxide and is that part richest in phosphorus. There can be no doubt whatever that while the furnace was working under the most intensely reducing conditions a portion of the metal below the hearth was being converted into what was, to all intents and purposes, wrought or puddled iron. How much of this puddled ball was actually present it is not possible to tell. The actual weight of the specimen was not more than 2 lb., but it was only a fragment broken from a larger mass which had been removed with other portions of the bear for remelting. A portion of it was taken to a smith's forge and heated to nearly the melting-point, and was forged down into a miniature puddled bar, 6 in. in length and ¾ in. square. There was no difficulty in forging it. A portion of this was reheated and bent over on itself, and then further heated to a welding heat, and this process was repeated several times, and finally the welded bar was forged down to a point. When cold the thin end was bent over without fracturing. Another portion after forging was nicked and broken, when the fractured ends showed a fibrous structure. It was wrought or malleable iron.

Owing to the refractory character of the oxide, it was difficult to remove it by forging when heated to whiteness, but for all that the metal could be forged and welded perfectly.

The forged bar was drilled and the drillings analysed with the following results:—



1. 2. 3. 4.

COCHRANE'S BEAR.—No. 3 BLAST FURNACE.

No. 6.—1. Piece of a mass of iron and cinder resembling a compressed puddled ball, from the hearth of No. 3 Ormesby furnace.
2. The same after heating to whiteness and drawing down to a bar.
3 and 4. The same as last after repeated forging, filing and welding, and bending cold.

* Paper taken as read at the meeting of the Iron and Steel Institute on May 3, 1918.

	Per Cent.	
Phosphorus in metallics	= 0·093	0·107 per cent.
Phosphorus in oxides ...	= 0·014	
Oxides	= 14·400	

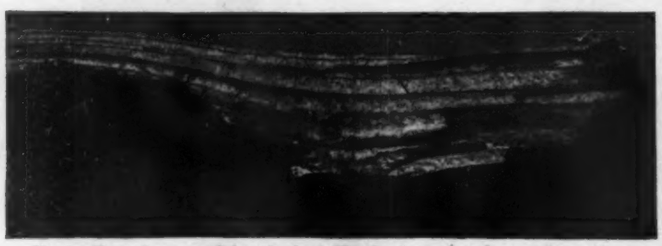
The external cinder contained :—

	Per Cent
Iron	= 71·30
Silica	= 3·80
Phosphorus	= 0·205

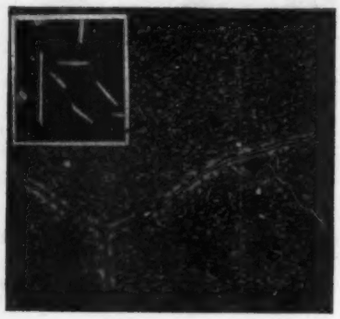
Pieces of the original metal and cinder, the puddled and welded and worked bar, were photographed and are shown in photographs Nos. 5 and 6. The fact that the external cinder contains so little phosphorus is proof that most of the phosphorus must have been removed from the metal before this oxide was made.

SECTION VII.

Decarburised Iron.—Having shown in Section VI that oxides of iron are sometimes produced by oxidation of the iron below the hearth level, and that these react on the end where the structure was columnar in character it varied between 0·90 per cent. and 1·5 per cent. The columns were separated by layers of free phosphide, and it was along these that fracture most readily travelled. There did not appear to be any intercolumnar spaces or iron oxide such as were found in the Skinningrove and Cleveland bears. It is probable that during its early history the columns were formed by compression of the semi-liquid metal throughout the whole mass, and variable phosphorus is due to variable pressure. The total absence of silicon and nearly all the manganese, and the absence of free oxides of iron between the crystals, suggests that the original liquid iron had been subjected to oxidation previous to its solidification—a process which would remove these bodies in the form of slag or cinder and at the same time remove a portion of the carbon. When the carbon was reduced to 2½ per cent. to 3 per cent. the mass would be nearly solid, and it was when in this condition that the pressure became pronounced. External oxidation continuing, the carbon would slowly be removed as in the process of making malleable iron. The columns through-



No. 8.—Part of a mass of decarburised Cleveland iron in columnar formation. Natural size. Each column is a single crystal of ferrite.



No. 9.—Section through part of three columnar crystals of ferrite, polished and etched. The minute white spots are crystals of Fe_3P. The white junctions are the same. The inset is a magnified view of the Fe_3P crystals.

the metalloids of the metal, finally removing the whole of the carbon, it only remains to give particulars of a very unique case in which a considerable mass of decarburised iron was found in a bear at the Cleveland Ironworks. Of this mass, weighing possibly more than 200 lb., only one piece weighing about 56 lb. was supplied to the author. It had been broken off a much larger piece, and every part of it was most grossly crystalline, the cleavage faces measuring from $\frac{1}{16}$ in. up to 1½ in. across, while cubic cleavages in the larger crystals were very perfect. Photograph No. 7, natural size, was taken of a small portion. At one end of the lump the iron was in columnar form, but this soon merged into the massive. The analysis was as follows :—

	Per Cent.
Iron by difference	99·135
Carbon	0·010
Manganese	0·043
Silicon	trace
Sulphur	0·200
Phosphorus	0·587
Copper	0·025
	100·000

The microscope revealed sulphide inclusions more or less globular in form, generally of a pale yellow colour, but some of these were associated with dove-coloured particles. The larger inclusions, yellow in colour, were much cracked, suggesting iron sulphide. The small percentage of manganese present would only combine with 0·025 per cent. sulphur, yielding 0·078 per cent. manganese sulphide. The balance of 0·175 per cent. sulphur would combine with 0·306 per cent. iron, yielding 0·481 per cent. iron sulphide.

The columnar portion, represented in photographs Nos. 8 and 8A, contained more phosphorus than the other portion. The free phosphide was mainly located at the junctions of the columns, but there were particles also inside the latter. The free phosphide separated was analysed and found to contain 15·48 per cent. phosphorus, which approximates closely to that of pure Fe_3P.

One interesting feature about this mass of iron is the variability of the phosphorus in different parts of it. Drillings taken from the part most highly crystalline yielded from 0·57 per cent. to 0·63 per cent., while at out would at first be separated by the ternary eutectic, but as the carbon was gradually removed the phosphorus would diffuse from the junctions into the columns. Where the percentage was small and the sides of the columns were free from intervening eutectic, they would crystallise or weld together, and be free to develop into the huge crystals actually found. Where the proportion of the phosphorus eutectic was great, time had not been sufficient to allow the whole of it to diffuse. As a result some of it remained between the columns, leaving brittle junctions.

It is possible that the larger amount of phosphorus found in the columnar part may have been derived from the part containing less phosphorus and was trapped there as it flowed outward.

In the case of the columnar carbonless iron from the Ferryhill bear the phosphorus in solid solution was 1·67 per cent., but in this also there was free brittle phosphide round the columns.

Another interesting feature about these decarburised portions is that when the phosphorus in solid solution exceeds about 0·6 per cent. there exist crystals of free iron phosphide within the body of the crystals of iron.

In portions of the iron from the columnar part there were, viz. :—

	Per Cent.	Per Cent.
Iron, phosphorus, &c.	94·3	= 0·623 phosphorus
Iron phosphide ...	5·7	= 0·883 ,,
	100·0	= 1·506

On dissolving away the iron solid solution with dilute nitric acid the phosphide crystals remained insoluble. They were idiomorphic and very minute, varying between 0·0015 mm. and 0·030 mm. in length.

The photograph No. 9 is of a section etched with a cupric reagent. The white bands are phosphide at the junctions of the columns and the minute spots in the body of the crystals are idiomorphic crystals of rhabdite, and the inset is a magnified photograph of the phosphide crystals. The decarburised iron of the Ferryhill bear consisted of :—

	Per Cent.	Per Cent.
Iron, soluble phosphorus, &c. ...	99·34	= 1·67 phosphorus
Iron phosphide, free	0·66	= 0·10 ,,
	100·00	= 1·77 ,,

Comparing the Cleveland with the Ferryhill iron, it will be seen that the amount of phosphorus in the latter in solid solution is nearly three times as great as in the former. If the iron is capable of holding 1·67 per cent. phosphorus in solid solution in the Ferryhill iron, why should not the whole of that in the body of the Cleveland iron have remained in solid solution ? The answer is that it depended on the period of cooling through a critical range, where phosphide falls out of solution. It must have been short in the case of the Ferryhill bear and prolonged in the other.

No. 8A.—Mass of decarburised iron from a Cleveland blast furnace. Natural size. The columns are separated from each other by brittle layers of Fe_3P.

The almost complete separation of the phosphide in meteoric irons leads one to conclude that the cooling through the critical range was prolonged sufficiently to allow the greater part of it to crystallise out. The analysis of a Mexican specimen was as follows :—

	Per Cent.
Iron	94·000
Nickel	5·050
Carbon monoxide	0·509
Carbon	0·040
Manganese	nil
Chromium	nil
Tungsten	nil
Silicon	nil
Sulphur	0·027
Phosphorus	0·277
Copper	nil
Arsenic	nil
	99·993
Phosphorus, soluble	0·067
Phosphorus, insoluble	0·210
	0·277

It is more than probable that had the cooling of the decarburised iron of the bears occupied years instead of days or weeks a more complete separation would have been effected.

Judging from previous research, we know that heating iron of similar composition to that of the Ferryhill bear at about 1,300 deg. C. and cooling to about 400 deg. C. in four or five days, only 0·9 per cent. phosphorus remained in solid solution, although before heating there was 1·6 per cent. We know that between 1,300 deg. and 1,000 deg. no free phosphide could possibly form, as 1,000 deg. C. is above the formation point of the binary eutectic; therefore the critical range must be below 1,000 deg. C.

This remarkable specimen naturally points to a range of temperature which may be favourable for the crystallisation of idiomorphic crystals of iron phosphides from solid solutions of that body in iron lying between 1,000 deg. and 500 deg. C.

It is the object of the author to determine what this is, in order to present the results in a separate note.

SECTION VIII.

Columnar and Dephosphorised Raw Iron.—In a paper by the author on phosphorus and iron* reference was made to a small specimen of decarburised iron in columnar form, obtained, from the bear of a furnace at Ferryhill, but it was not till 1913 that masses of columnar iron were found in the hearth of furnaces which had been making Cleveland iron.

One of these furnaces referred to is one of several furnaces owned by the Skinningrove Iron Company, Limited, Carlin How, Yorkshire, and the metal was a portion of a huge mass which had solidified in the hearth.

No. 10.—Columnar mass of metal from the hearth of a Wigan furnace, typical of similar masses in several other furnaces.

Mr. T. C. Hutchinson, the managing director, supplied the author with a specimen and its analysis.

The specimen consisted of a series of columnar masses of iron 3 in. to 4 in. in length. These were separated at intervals by porosities and by oxide scale and free carbon. The analyses were as follow:—

	Stead. Per Cent.		Skinningrove. Per Cent.	
Iron	...93·400		—	
Combined carbon	... 0·562	2·202	0·480	1·53
Graphite ...	... 1·640		1·050	
Manganese ...	... 0·173		—	
Silicon ...	... 1·166		1·410	
Sulphur ...	... 0·103		0·082	
Phosphorus ...	... 0·155		0·090	
Oxygen, &c.	... 2·801		—	
	100·000			
Specific gravity	... ...	...	7·14	

The metal represented such interesting features that by the courtesy of Mr. Hutchinson, the author visited the works and examined portions of the "bear" which had been blasted out of the hearth. There was about 500 tons of broken-up pieces. From information kindly given it appeared that the lining at the top of the furnace fell in when the furnace was being blown out more than ten years ago, and the blast was turned off while the furnace shaft still contained unburnt coke and other material. The whole mass, including the liquid metal below the hearth level, was then allowed to cool naturally. When blasting out this "bear" the workmen came upon a quantity of metal exactly in the centre of the mass exceedingly tough and difficult to break. When broken up it presented the appearance of a columnar basaltic formation with vertical columns ½ in. to ¾ in. in diameter and above 1 ft. in length. On analysis it was found to be nearly free from phosphorus, and as nothing but phosphoretic pig-iron had been made in the furnace during its life, it surprised everyone.

With the evidence available it is possible to trace what had occurred after the stoppage of the furnace. The huge mass of liquid iron, considerably over 600 tons, had cooled with extreme slowness, being under the ground level and covered with a mass of hot material. The outer portions would, of course, solidify first and expand as the graphite separated, and the enormous solid cylinder of metal so formed in cooling must have contracted and compressed the fluid inside, and as long as the latter was quite fluid the central mass would rise vertically, but in course of time it would begin to freeze and the first purer crystallites of the fir-tree type would separate from the liquid, and eventually the whole central column would become a mixture of pure solid interlacing crystals with the liquid ternary eutectic between their branches.

When this stage was reached and the surrounding solid ring continued to contract round the pasty mass, only one thing could happen, the same as occurs when nearly solid Cleveland iron is subjected to pressure; the eutectic was forced to pass away from the solid crystallites, and in doing so was obliged to pass upwards and make a series of parallel vertical passages along which to flow. The solid crystallites were thus pressed together into solid vertical columns, while along the junctions continuous streams of the eutectic would flow upwards and escape into the upper layers. After the inside of the columns had been freed from liquid the continued pressure would finally squeeze out practically all the phosphorus-rich liquid still existing between the junctions of the columns. At this point, when no more liquid could be expressed, the whole plastic highly heated mass —probably at a temperature of 1,000 deg. C.—would itself have to elongate upwards, and it was at this stage the columns must have been sliding one against another along the original junctions where traces of the mother liquor remained mechanically imprisoned.

As cooling was continued and the outer mass ceased to contract or contracted slowly, the central portion, being the last to cool, must at one stage have exerted tensional pull on the metal surrounding it, but not being able to pull it inwards, it partially separated along the original planes of flow, into loosely attached vertical columns, leaving porous passages between them. Probably oxidising gases such as water vapour passed into the central mass, along the contraction passages, not only oxidising the surfaces of the columns, but actually decarburising the iron. It is difficult to offer any other explanation to account for the oxide of iron which partially covered the surface of the columns themselves. How long about 800 tons of metal took to cool down none can tell; it would probably be more than three months.

Soon after the discovery of the columnar central masses of iron at Skinningrove, a similar formation was found in the hearth of No. 8 furnace at the Cleveland Iron Works of Messrs. Bolckow, Vaughan and Co.

The columns rested on solid brickwork, and near that point they were strongly coherent, but at a vertical distance of from 3 in. to 1 ft. or more they were quite readily separated from each other.

Mr. D. Sillars, the chemist of the company, tested a series of samples and found the following results:—

	Minimum. Per Cent.	Maximum. Per Cent.
Silicon	1·24	1·90
Manganese	0·11	0·31
Sulphur	0·08	0·20
Phosphorus	0·15	0·95

The metal was oxidised to a surprising extent, and, as will be seen by comparing the analysis with that of the metal from Skinningrove, the phosphorus has not been so completely removed.

One of the samples taken from near the top of the "bear" contained:—

	Per Cent.
Manganese	8·50
Sulphur	3·57
Phosphorus	0·95

The drillings were free from slag.

A similar columnar formation was discovered in a bear from No. 4 Ormesby furnace.

A sample of this, almost identical in appearance and from the same central position as the columnar material from the Skinningrove bear, had the following analysis:—

	Per Cent.
Combined carbon	0·91
Graphite	2·13
Silicon	1·13
Phosphorus	0·078

Mr. Cochrane has given particulars of the performance of No. 2 furnace during its life, as follows:—

The dimensions of the furnace were:

	Ft.
Height	90
Bosh	23
Hearth	8

Diameter at nose of tuyere, 6 ft.; June, 1880, 7 ft. 4 in.; 1890, 10 ft.

Blown in ... ... May, 1876.
Blown out ... ...May 30, 1914.
Total make ... 1,365,349 tons 6 cwt.

	Average Make per Year.	Blast-Pressure at Ptug Hole.	Coke per Ton Pig.	Ash in Coke.	Raw Iron-stone.	Swedish Ore.
	tons.	lb.	cwt.	per cent.	cwt.	cwt.
1877–1881	23,091	3·84	20·43	7·19	66·21	Nil
1882–1886	26,932	3·07	19·85	7·81	66·89	,,
1887–1891	37,336	4·80	20·12	7·89	66·00	,,
1892–1896	41,635	5·01	21·04	8·45	69·32	,,
1897–1901	41,122	5·31	20·02	9·27	68·24	,,
1902–1906	39,845	5·51	20·29	9·85	67·42	,,
1907–1911	42,766	5·60	20·11	11·45	66·08	1·36
1913	41,719	5·55	21·60	11·72	64·76	1·70

The diameter of the hearth was increased in 1887 from 8 ft. to 10 ft. 11 in.

THE BEARS.

There were two bears—an upper and a lower—separated by a layer of kish, &c. Their shape and position are shown in Fig. 1, page 660 *ante*, and their analyses are as follow, namely:—

	Upper Bear. Centre.	Upper Bear. Side.	Lower Bear. Centre.
	per cent.	per cent.	per cent.
Iron..	81·120	85·479	94·449
Manganese	8·280	2·016	0·144
Graphite	3·450	7·500	2·700
Combined carbon	1·000	1·070	0·720
Silicon	1·130	1·380	1·380
Sulphur	4·600	1·068	0·095
Phosphorus	0·420	0·987	0·512
	100·000	100·000	100·000

The remarkable feature is the relatively small quantity of phosphorus in the centre of each bear.

Specimens were sent to the author for micro-examination, who reported as follows, viz.:—

"The metal from the lower bear was analysed after micro-examination. There was a complete absence of any free phosphides. The analysis of the lower bear, as made by my assistants, was as follows, namely:—

	Per Cent.
Manganese	0·417
Total carbon	3·944
Combined carbon ... ... traces to	0·7
Silicon	2·034
Sulphur	0·041
Phosphorus	0·437

"The chief point of interest in this bear is that the ½ per cent. of phosphorus is completely diffused in the matrix, in solid solution, together with the silicon, the reason for this being a very long heating at temperatures below 1,000 deg. C."

The columns adhered more closely than they did in the other bears, but were quite free from oxidation.

Another bear from a blast furnace at the Wigan furnace, kindly supplied by Mr. Percy, general manager, had the same columnar structure. The average analyses of the metal the furnace had been producing, and of two pieces of the columnar mass, were as follows:—

	Original Metal. Per Cent	Columnar Mass. 1. Per Cent	Columnar Mass. 2. Per Cent.
Graphitic carbon }	3·20	1·46	0·59
Combined carbon }		traces	0·57
Manganese ...	1·25	0·72	1·18
Silicon ...	...0·75 to 1·25	0·58	0·44
Sulphur...	...0·06 to 0·11	0·30	0·55
Phosphorus	...1·75 to 2·35	0·87	0·49
Phosphorus as Fe_3P		0·28	0·194
Phosphorus in solid solution...		0·59	0·360

The photograph No. 10 is of a portion of this bear, natural size, and shows most clearly the columnar structure.

SUMMARY TO SECTION VIII.

From the evidence yielded by the examination of bears from at least six different furnaces, three of which had produced Middlesbrough iron, and one basic iron at Wigan, the columnar structure is quite common, and in all cases the metal of which the columns were composed contains much less phosphorus than the metals from

* Journal of the Iron and Steel Institute, 1900, No. II, page 123. ENGINEERING, Oct. 19, Nov. 2, 16 and 23, 1900.

which they were derived. Compared with 100 parts phosphorus in the original metal, the phosphorus remaining in the columns amounted to :—

	Per Cent.
Skinningrove Ironworks	7
Cleveland Ironworks	10
Ormesby Ironworks	7
Wigan Ironworks	25

There can be little doubt that in each case what produced the columnar structure also eliminated the phosphorus, and this was pressure on the metal during cooling when the mass was in a semi-solid condition which squeezed out portions very rich in phosphorus along vertical channels which eventually became juxtaposed faces of the columns themselves.

(To be continued.)

NEW DISINFECTION PROCESS FOR SHIPS.—The disinfection of plague-infected ships is a serious problem, and even when there is no suspicion of plague, the task of killing all the vermin and low organisms that foul a ship and its cargo, is no easy task. The disinfection is usually performed with the aid of sulphur dioxide by the Clayton or some other process. Sulphur dioxide has the merit that nothing alive will withstand it, even bacteria, and that it is, in spite of this, only moderately poisonous to man. On the other hand, the SO_2 cannot be applied to certain cargoes, such as grain, wheat, oil seeds, &c., because it deprives them of their germinating power. Some years ago, the Nocht-Giemsa process was introduced, especially for killing rats; in this case the agent is carbon monoxide. The gas is fatal to rats and mice, but is fatal also to man, without giving warning by its smell, as the SO does, whilst it does not even destroy fleas, not to speak of bacteria, though it does not spoil grain cargoes either. At Stettin, we see from the *Zeitschrift des Vereines Deutscher Ingenieure*, of March 30, 1918, the medical authorities have recently constructed for the harbour service a disinfecting-ship, in which the two processes are combined. The Nocht-Giemsa gas is prepared by burning coke with an insufficient supply of air, and consists of carbon dioxide, carbon monoxide, and nitrogen. The first plant built for this purpose had done good service in rat-infected buildings and vessels, but was not much wanted owing to the limitations of its powers. On the new steamer, which has a length of 30 m. and 5·4 m. beam, and is built with two bulkheads, the gas generator has a diameter of 2,450 mm. and a height of 2,380 mm., and is capable of supplying 3,000 cub. metres of a gas (containing from 5 to 8 per cent. of CO) per hour. The gas is distributed from a 180-mm. main, running along the port side, to the 10 nozzles to which rubber hoses, 75 mm. in diam., can be joined. The sulphur for the SO_2 plant is melted in an oil bath at 160 deg. C., when it forms a mobile liquid (it turns viscous at higher temperature), and the liquid sulphur drops in to the furnace through a regulating valve; the SO_2 gas is cooled before use. The ship is so constructed that the two gases can be used separately or combined; in what proportion they are mixed in the latter case is not stated; there is little experience, so far, probably.

WASHING WITH OXYGEN-LIBERATING CHEMICALS.—Of late years certain chemicals, notably sodium perborate, have enjoyed favour in laundries because they are said to cleanse the clothes quite as well as good soaps and not to call for the vigorous rubbing and scrubbing generally applied in laundries to the ruin of the cloth. But complaints have frequently been made that in spite of the absence of scrubbing such linen and cotton articles are quickly destroyed. The chemicals in question liberate oxygen, which is the cleansing and bleaching agent; in a certain way chlorine ranks with them, because it combines with the hydrogen of organic compounds, liberating the oxygen; but chlorine stands apart in so far as it destroys organic matter first, and experts did not fail to point this out and to certify that the oxygen-washing did not corrode the textile fibre. But Professor P. Heermann, of the Materialprüfungsamt near Berlin, objects (*Chemiker Zeitung*, February 16, 1918) that most experiments have been made with clean linen and cotton, which some of those chemicals hardly corrode indeed, but that the conditions may be very different with soiled linen and cotton. He had for some years already drawn attention to the different result obtained under different conditions and with different waters, and he now gives figures as to the mechanical strength of specimens of cotton and linen, tested as supplied, and after washing in the clean and in the soiled conditions, with various soaps and chemical agents, by experienced laundresses. The reduction in strength was markedly greater—but only after washing with the chemical agents, not with ordinary soaps—when the material was soiled, than when clean, and a great deal depended upon the nature of the soiling and upon the presence of materials which acted as oxygen carriers. Prominent among the latter were copper salts, especially the sulphate; copper staining, particularly where in contact with iron stains, would eat holes into linen (and also into cotton) during the first washing. Judicious brushing and rubbing did the cloth little harm. The point is not unimportant as many people are now exposed to getting their clothes soiled with copper and other metals, and as soaps are, to all accounts, very scarce in Germany. The perborates are prepared from borates and boric acid by the action of peroxides (of hydrogen or alkalis) or by electrolysis. Sodium perborate is a crystalline body, stable at ordinary temperature, but decomposed by hot water; the sodium perborate lye used in washing would not contain more than 0·1 per cent. of active oxygen.

CATALOGUES.

Cement-Making Machinery.—Messrs. William Johnson and Sons (Leeds), Limited, send a reprint of some articles from *The Engineer* illustrating and describing their complete series of machines for manufacturing Portland cement.

Electric Gear.—Messrs. George Ellison, Perry Bar, Birmingham, have issued a useful abridged catalogue of 84 pages. Illustrations and figures are given in sufficient detail for general purposes and tables of prices for each size, &c. Reference numbers are added so that a fully detailed catalogue of any item may be sent for if required. A new special catalogue comes from the same firm stating full particulars and prices for trailing cable sockets and plugs for air-break gate-end boxes, suitable for c. and a.c. circuits up to 650 volts. These fittings are suitable for factories and non-fiery mines where a convenient plug is wanted for connections with portable tools. The plug is interlocked with the breaker to prevent withdrawal while the current is flowing. The mountings are for the wall or stand on floor as required.

Coal Conveying Plant.—Conveying plant for coal, &c., is being rapidly developed, chiefly owing to the opportunities offered by large electric generating stations and improved organisation at pit heads. Messrs. Edward Bennis and Co., Limited, Little Hulton, Bolton, and 28, Victoria-street, S.W. 1, send us a catalogue illustrating many forms of this machinery. Link, bucket, band and screw conveyers are all used to unload barges and deliver to stores or direct to the furnace hoppers. For ash removal the vacuum system is favoured for large installations, the plant being adapted for extracting soot and dust from boiler tubes, flues and economisers also. In many cases the plant spreads over large areas, bringing in coal, supplying furnaces and clearing away the refuse. At many points automatic control is ingeniously and effectively established.

Liquid Fuel.—When coal was the only fuel many a respectable millowner clung to the idea that the cheapest must be the most profitable; while the technical engineer—and the intelligent stoker, for that matter—insisted that value-in-use does not always humbly follow exchange value. Coal is now a subject of respectful, even learned, study. Liquid fuel users are going through a similar educational process and are finding that there is a right way and many wrong ways of burning petrol, benzol and oil. A series of tests with these three fuels was made by Messrs. Brown Brothers, Great Eastern-street, E.C. 2, with the 10-h.p. engines of a motor car, the special purpose being to demonstrate the merits of their "Calo" air heater, described in these notes of January 11. Many useful figures are given, the general effect being that "war petrol" requires a higher preheat than 'petrol" to make it burn economically, and that benzol and oil must be preheated to certain degrees suitable to each. Turning benzol into a suitable burning gas requires a great deal of heat; it was found that air entering the carburettor at 100 deg. F. dropped to 37 deg. F. in the induction pipe.

Steel Driving Belts.—The information wanted, especially by mill owners and millwrights, about these belts, is to some extent supplied by a catalogue from Steel Belts, Limited, Granby row, Manchester, and an enclosed paper by Mr. B. D. Potter. It is now fairly well known that steel belts can be used successfully and with economy; provided the pulleys run true, and are substantial, that the shafts are very truly aligned, and that these true conditions can be maintained. Mr. Potter frankly emphasises these points. The pulleys must be flat and have a special friction surface, but existing pulleys can generally be so adapted, including rope grooved pulleys. The catalogue shows chiefly main drives, for mills, from engine to line shafting. The exceptions are, however, interesting, and include a stone crusher using 18 h.p., driven by a steel belt 4 in. wide; both pulleys are 33 in. diameter, and only 9 ft. 5½ in. apart at centres. There is also a drive from gas engine to dynamo, of 50 h.p., by a 4 in. steel belt, the pulleys 8 ft. and 2 ft. diameters and 17 ft. 6 in. apart at centres. There is also a case of a vertical drive of 100 h.p. by an 8 in. steel belt. The main drives, of usual form—*i.e.*, with large pulleys and long centre distances—are numerous. The highest and lowest belt velocities mentioned are 2,800 ft. per minute and 1,584 ft. per minute. The steel belt is almost a rigid drive, the loss of power by slip being estimated at 0.5 per cent., as compared with 6 per cent. for ropes and 4 per cent. for leather. Millwrights do not like belt slip to be represented entirely as loss of power—it is also a safety characteristic—not necessary in every drive, but in some cases very much required. The steel belt takes less width room and less sagging room. In cost it is less than leather or ropes when new pulleys are included. A charcoal steel is used, rough rolled at red heat, cold rolled to thicknesses of 0.2 mm. to 0.9 mm. and hardened; tensile strength, 95 tons per square inch. Evidently there is a future for steel belting, and the catalogue gives some useful information as to the special conditions suitable for it.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON), LEEDS CENTRE.—On the proposal of Mr. Norman Lockyer, and with the willing approval of Mr. Stamer, the committee have unanimously accepted the courteous invitation to visit the N.E.R. locomotive works at Darlington, on the 25th inst. They ask all the members who possibly can to make a special effort to be present. Members will proceed by tram to locomotive works office, where they will be received by Mr. Stamer, and a brief description of the works will be given. Small block plans will be issued. Members can choose which shops they wish to see specially, and can divide and be grouped accordingly at the office before entering the works.

THE GERMAN EXPLOSIVES INDUSTRY.

THE Dynamite Company, formerly Alfred Nobel and Co., Hamburg, shows profits from manufacture, dividends, interest, &c., for last year, amounting to 12,827,218 marks, against 15,762,055 marks for the previous year. This, however, is not synonymous with a decrease in profits, a sum of 5,000,000 marks having been put aside as security in connection with obligations arising from military contracts during the war; in previous years a similar reserve for the same purpose had been deducted from the profits. The report states that the extensive new buildings and extensions undertaken in harmony with the Hindenburg programme, have, for the greater part, been completed, although a portion will only be finished during the current year. As some of these extensions were in use during 1917, it may be taken that the turnover, and with it the profits, have increased rather than receded. Buildings, works, sites, &c., figure in the balance-sheet for 18,513,835 marks at the end of December, 1917, against 1,136,074 marks twelve months earlier. The extensions and new installations are consequently responsible for an increase of about 17,400,000 marks, but the actual outlay has been considerably higher; owing to the high wages and the high prices for raw materials, the original calculations were very materially exceeded, so that it was impossible fully to write them off, as had been desired. Several reserves, or addition to funds, have been dispensed with, but the dividend has been maintained at 20 per cent. Claims on connected companies have risen from 49,200,000 marks to 94,200,000 marks. The firm has found it expedient to avail itself of a bank credit amounting to 19,700,000 marks, and a credit from the military authorities of 17,100,000 marks in connection with its large extensions.

The United Köln-Rottweiler Powder Works, Berlin, also pay 20 per cent. for last year, as for the preceding year. This company also, in obedience to the Hindenburg programme, has had to go in for large extensions, which, with welfare installations, far exceeded the capacity of the increased capital of 33,000,000 marks, but which mostly have been covered beforehand; further substantial sums under the same heads have been and will have to be paid in the course of the current year. The war tax reserves have been previously deducted from the figures. From different sources, and including a substantial figure carried forward, a sum of 23,399,117 marks becomes available against 26,331,765 marks, for the previous year. A sum of 5,000,000 marks is reserved for peace reconstruction, besides other reserves and writings-off on old installations, and the actual surplus amounts to 12,298,438 marks, against 14,699,401 marks for 1916. The dividend absorbs 6,600,000 marks, and 4,676,240 marks are carried forward against 6,577,264, marks in the former balance-sheet. The report says that the building programme, in spite of many difficulties, has been carried out, all the new buildings had been put in use during 1917, and the turnover had materially increased. It was necessary to provide for new peace contingencies, in connection with which experience gained during the war would prove helpful. The figures in the balance-sheet are materially altered; land and buildings have risen from 6,867,681 marks to 17,220,734 marks, machines from 19 marks to 9,012,214 marks, utensils, &c., from 25 marks to 958,941 marks, stores, &c., from 23,109,567 marks to 49,152,220 marks, &c.

SHIPBUILDING IN FINLAND.—A distinct activity prevails in Finland in the matter of increased shipbuilding, and special attention is being paid to the building of wooden vessels; thus, a vessel of 1,600 tons gross is being constructed.

COMMITTEE ON PRODUCTION.—Mr. E. C. K. Gonner, of the University of Liverpool, has been appointed by the Prime Minister to be an additional chairman of the Committee on Production. Mr. Gonner is a member of the staff of the Ministry of Food, and a well-known authority on economics.

IRONSTONE IN NETHERLANDS INDIA.—According to *The London and China Telegraph*, a telegram appearing in the Dutch newspapers states that iron-ore beds, estimated to contain upwards of a 1,000,000,000 tons, the exploitation of which would be easy, have been discovered in the Verbeek Mountains, in the island of Celebes.

BLAST FURNACE SLAG IN CONCRETE.—Tests on concrete made with blast furnace slag at the University of Cincinnati give indications of the satisfactory nature of this type of aggregate, reports *Engineering News-Record*, New York. (1) Compression tests show slag and bank sand as used in 1:2:4 concrete to be 17 per cent. stronger than concrete made with pebbles and bank sand. (2) Concrete made with slag and bank sand shows greater elasticity and resistance to fracture than pebble concrete. (3) Weight of slag and bank sand concrete is 16 per cent. less than pebble concrete for a 1:2:4 mixture. (4) Tensile strength of 1:3 slag mortar is 12·5 per cent higher than bank sand mortar and 62 per cent. higher than standard Ottawa sand mortar. (5) Bond strength of slag and bank sand concrete is 15 per cent. higher than 1:2:4 pebble concrete. (6) Slag and bank sand concrete withstands higher temperature than crushed stone and bank sand concrete. (7) Transverse beam tests comparing strength of slag and bank sand beams with crushed stone (1:2:4 mixture) show slag beams to be 42 per cent. stronger. (8) Slag concrete withstands action of acids better than do crushed stone samples. (9) No appreciable corrosion of steel embedded in slag concrete is noted at the end of one year. (10) Slag concrete resists shock and impact much more successfully than pebble or crushed stone concrete.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c. of the Communicators are given in italics.

Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

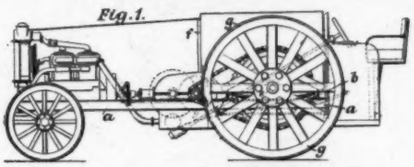
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

AGRICULTURAL APPLIANCES.

114,811. Alldays and Onions Pneumatic Engineering Company, Limited, Birmingham, and N. L. Hilton, Birmingham, and C. E. Simms, Birmingham. Motor Tractors. (2 *Figs.*) May 5, 1917.—The invention consists of the improvements hereinafter described in or relating to motor tractors. In constructing the improved motor tractor the frame of the vehicle is made of two longitudinal parallel bars or members *a*, preferably of a channel shape in cross-section, and transverse

Fig. 1.



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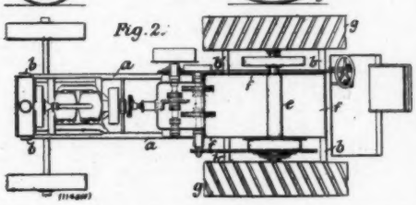
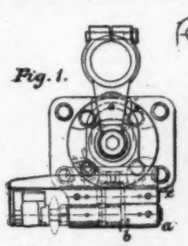


or crossing bars or members *b*, preferably of the same cross-section as the longitudinal bars. On the rear transverse or crossing bars *b* of the frame a water ballast tank *f* is arranged, which tank may be filled with water or other ballast when the tractor is to run on ordinary macadam or like roads in order to ensure the requisite weight to obtain proper adhesion of the wheels *g* of the tractor on the road for traction purposes, the water tank being emptied when the tractor is to be used on agricultural land so as thereby to reduce the weight of the vehicle. (*Accepted April* 24, 1918.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

114,774. Smith and Coventry, Limited, and I. H. Wright, Salford, Manchester. Milling Machines. (5 *Figs.*) October 13, 1917.—This invention relates to milling machines, and particularly to machines in which racks are produced by milling. The invention comprises the combination with the spindle carrying the milling cutter and having a spiral wheel thereon, of two spindles or shafts, each in driving connection with said spiral wheel, one of said spindles or shafts constituting the power shaft and having thereon two spiral pinions, one of right-hand and the other of left-hand pitch, the one pinion driving the milling cutter spindle direct, whilst the other drives it through the second spindle aforesaid. The milling cutter spindle *a* has

Fig. 1.



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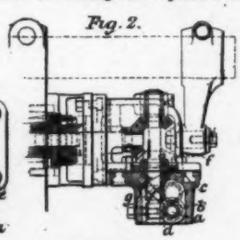


Fig. 3.

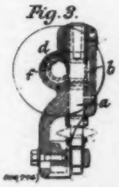


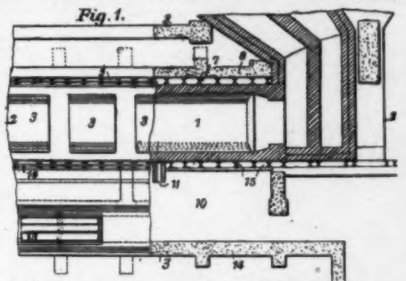
Fig. 4.

thereon a spiral wheel *b* which is engaged by two spiral wheels *c*, *d*. The wheel *c* is secured upon a spindle *e* parallel with the spindle *a*, and the pinion *d* is mounted upon the power shaft or spindle *f*. The latter has a second spiral pinion *g* thereon of opposite pitch to the wheel *d*, and such pinion *g* drives the spindle *e* by engaging with the wheel *c* thereon, the latter engaging in the manner of a spur wheel with the spiral wheel *b* on the cutter spindle *a*. With the aforesaid arrangement, the right-hand and left-hand spiral pinions *d*, *g*, cause the power shaft *f* to be in a more or less balanced condition, and owing to the duplication of the driving gears, the amount of power which can be efficiently transmitted to the cutter spindle is greatly increased. (*Accepted April* 24, 1918.)

MINING, METALLURGY AND METAL-WORKING.

114,751. A. Sahlin, London. Heating Pit Furnaces. (3 *Figs.*) August 9, 1917.—This invention relates to the construction of heating pit furnaces. According to this invention, it is proposed to support the line of pits by a plate resting on a number of longitudinal joists, which in their turn are supported by concrete or brick piers, the arrangement being such that the air can circulate under the bottom plate and between the supporting joists along the entire length of the furnace. The furnace comprises a continuous chamber 1, divided near the top by means of a number of arches into a plurality of separate pits furnished with covers 3. The bottom of the furnace chamber is supported on a plate 4 resting on a plurality of longitudinally disposed joists 5, which, in their turn, are supported by concrete or brick piers 6, the arrangement being such that the air can circulate under the bottom plate 4 and between the supporting

Fig. 1.



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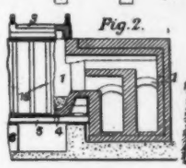
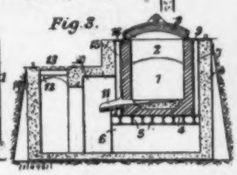
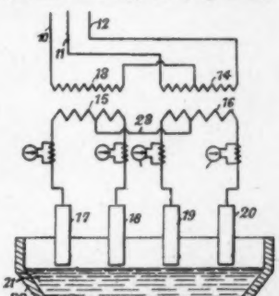


Fig. 3.



joists 5 from one end of the furnace to the other. A plurality of vertically disposed joists 7 are arranged between the back wall of the furnace and the concrete wall 8 constituting the ditch; such joists, which constitute a series of vertical flues or air shafts, are supported on the plate 4 and extend up to the level of the top of the pit where they are covered by a suitable grating 9. The front of the furnace is formed by a row of chambers 10 built in concrete in which the pans, for receiving the slag which passes from the furnace down the spout 11, are adapted to be placed and from whence they are removed through apertures 12 furnished with covers 13. Between the concrete arches of the chambers 10 and the upright wall 14 forming the front of the ditch and the front brick wall of the furnace a space is left in which a further series of joists 15 covered by a grating 16 is placed, such joists forming a further series of flues or air shafts. (*Accepted April* 24, 1918.)

111,104. J. T. Dixon, Detroit, U.S.A. Electric Furnaces. (2 *Figs.*) October 14, 1916.—The invention has reference to steel furnaces of the type in which the arcs which supply the heat are formed by currents passing from and to movable electrodes suspended above the bath. Three-phase current is delivered over the mains 10, 11 and 12 to two Scott-connected transformers whose primaries are shown at 13 and 14 and whose secondaries 15 and 16 supply current of very high amperage to the four electrodes 17, 18, 19 and 20. The bath or material to be acted upon, shown at 21, is carried by a suitable crucible 22. It will be seen that each pair of electrodes 17, 18, and 19, 20 respectively, belongs virtually to an independent single-phase circuit since all the current passing through either member of either pair finds its way back through the other member of the same pair. The consequence is that either 17 or 18 may be much nearer the bath 21 than the other member of its own pair, and may indeed be in actual contact with the bath, thereby extinguishing the arc beneath it, without necessarily betraying the fact through an



ammeter. This follows from the fact that the increased length of one of a pair of such arcs may well compensate for the decrease in length of the other arc, thereby producing the same total resistance as existed when the arcs were equal. The patentee has found that by supplying an electrical connection, as by the conductor 23, between the neutral points of the two secondaries 15 and 16, the necessity for voltmeter or potential readings or control is entirely obviated, and the problem of regulation can thus be reduced to a simple ampere or current volume reading or control. By employing the connection 23 the current leaving any one of the four electrodes 17, 18, 19 and 20, does not return exclusively through the single electrode which is directly connected to the same secondary as itself. The consequence is that, if the electrode 17, for instance, approaches too near to the bath 21, thus shortening its arc, a single ammeter related exclusively to its appropriate supply conductor will indicate an increase of current and betray the fact that one certain electrode is too near the bath. (*Accepted April* 17, 1918.)

114,446. W. Fennell, and The British Carbonising Company, Limited, Gloucester. Case-Hardening Iron and Steel Articles. (5 *Figs.*) January 27, 1917.—This invention relates to the carburisation of iron and steel articles of various kinds for the purpose of case-hardening them. According to the invention, the carburisation of iron and steel articles for the purpose of case-hardening them, is effected by a solid carburising or case-hardening composition or material (hereinafter called the carburising material) in the presence of gas or vapour under a substantial pressure, say, of the order of about 15 lb. to the square inch and upwards, within an externally-heated closed space or chamber (hereinafter called a muffle) in which the carburising material and the articles are placed, and in which the gas or vapour is generated. The muffle is made in the form of a cylindrical metal tube *a*, arranged to extend in a horizontal or slightly inclined direction through a furnace chamber *b* in the opposite end walls of which it is mounted to rotate in a gastight manner. The tube is closed at one end and rotated by any convenient means. The other end of the tube *a* is provided with a removable gastight closure *i*, by removal of which the articles *j* to be carburised and the carburising and gas or vapour-producing material *k* can be readily introduced and through which the heated carburised articles and remaining carburised material

Fig. 1.

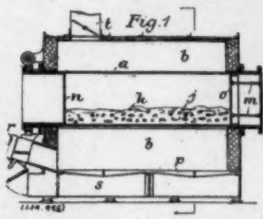


Fig. 2.

can be afterward withdrawn. The cover *i* may be a plate secured in a gastight manner to the flanged outer end of the tube *a*, and carrying, on its inner side, by means of rods *m*, an inner plate *o* that serves to confine at that end of the tube the articles and carburising material within the externally-heated portion of the tube *a*, another internal transversely arranged plate *n* fixed in the tube, and constituting, it may be, the end wall thereof, serving the same function for the opposite end portion of the tube. The furnace chamber *b* burns solid fuel supported on a grate *p*, and surrounds the muffle. *r* is a fire door, *s* an ash pit and *t* a chimney. When the muffle *a* is partly filled with the carburising and gas or vapour-producing material *k* and articles *j*, the cover *i* secured in place and the tube rotated, the carburising and gas or vapour-producing material and articles will be caused to move one over the other so as to be brought into effective contact with each other, and gas or vapour will be evolved from the carburising material, but as such gas or vapour is prevented from escaping from the muffle it will rise in pressure and assist in the rapid carburisation of the articles, the depth of carburisation depending upon the duration of the process. (*Accepted April* 17, 1918.)

PUMPS.

114,787. Albion Motor Car Company, Limited, Scotstoun, and T. B. Murray, Scotstoun. Lubricating Pumps. (2 *Figs.*) November 28, 1917.—The invention relates to mechanical lubricators of the type in which a pump element mounted upon a rotating disc is operated by a stationary cam, and delivers to successively uncovered ports on rotation of that disc. The disc is rotated by ratchet mechanism from an engine-driven shaft. The pump element A is mounted upon a disc having ratchet teeth B upon its periphery and retained against retrograde movement by a stationary blade-spring pawl C. Adjacent to the disc, and on an axis parallel with its axis, is a lever D rocked by crank-pin E on an engine-driven shaft F. The crank-pin has on it an externally spherical anti-friction roller

Fig. 1.

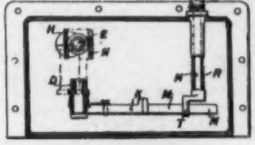
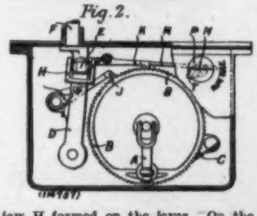


Fig. 2.

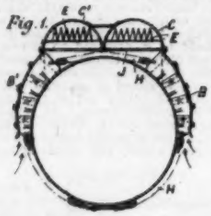


engaging a jaw H formed on the lever. On the lever D are mounted two pawls J, K, controlled by springs in suchwise that they both normally engage the ratchet teeth B. In order that the pawl K, of greater throw, may be thrown out of engagement when it is desired to reduce the lubricant feed to a minimum, there is provided on it a finger M adapted to be engaged by a pin T on an arm on a shaft N extending out through the lubricator case and provided with a hand button P. A spring R controls endwise movement of the shaft N, so that the button may be withdrawn slightly and a detent engaged with either of two recesses, and the pin T so held either out of or in contact with the finger M, in the latter case so raising the pawl K by means of the finger M that it is held clear of the ratchet teeth B throughout its stroke. (*Accepted April* 24, 1918.)

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

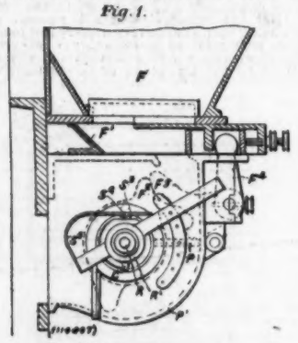
114,473. O. P. Macfarlane, London. Steam Generators. (14 *Figs.*) April 4, 1917.—The invention consists in apparatus for promoting the circulation of the fluid in a steam generator comprising saddle-like chambers partially surrounding a portion of the furnace flue or flues or tubes and of gradually increasing area from the opening upwards and surmounted by a hood or hoods of gradually expanding area from one end to the other, and of a semicircular or arcuate formation in cross-section. When applying the improvements to steam generators as shown in which a single flue is dealt with, there is placed over the flue two saddle-like members B, B1, formed of a series of plates linked or pivoted together so as to make a flexible bandlike casing, having ends that enclose a space around the tube through which the water will

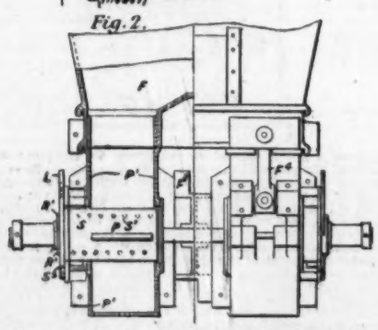
pass, the casing being of such configuration that the water at entrance passes through a smaller area than that provided at the upper end of such saddle members. There is secured to the upper enlarged ends of such saddle members, hood or nozzle casings, C, C1, preferably of semicircular or curved configuration, and so constructed that there is an enlarged area at the outer end, conical-like in form, for rapidly ejecting the expanding current of water and steam with the bubbles or globules within



such after it has passed between the confined area of the saddle members and the circumference of the flue. It is preferred to arrange upon the outer end of this deflecting hood, two comblike plates E, E1, to break up the steam and, as far as possible, prevent priming or wet steam from passing. The saddle members are tied together by bolts J and shackle and chain devices H, these simple means permitting saddles and fittings to be applied without in any way interfering or modifying the construction of the boiler or furnace tube. (*Accepted April* 17, 1918.)

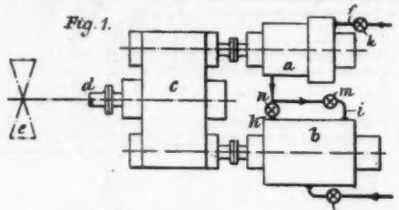
114,497. W. H. Holehouse, Bradford, and W. Holehouse, Bradford. Mechanical Stokers. (3 *Figs.*) April 19, 1917.—This invention relates to mechanical stokers for boiler furnaces. R is the usual revolving shaft on which is mounted a driving flange R1 carrying a cam C. Around and unconnected with the shaft, except as hereinafter described, is mounted a cylindrical case S containing a coil spring S1 (Fig. 2) having one end fastened to the case and the other to the driving flange R1. A recess S3 is formed in the case to receive a catch S4 on spring S5, connected with a lever L, which may be adjusted and held in varying positions. The cam C is adapted to engage and release the spring catch. The shovel comprises a steel plate P carried by the cylindrical case S. The shovel works in a shovel-box P1. Above the shovel and shovel-box is situated the feed-box F, having a feed ram F1 adapted to deliver the fuel in a

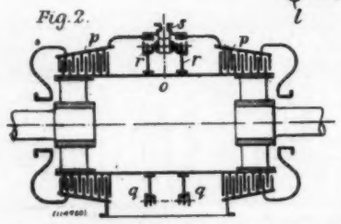




direction away from the furnace. Motion is given to the ram by means of cams F2 on the shaft R engaging a lever F3 which, when operated, actuates lever F4. If the shovel P be in its dead position, that is horizontal, fuel will have been fed to its upper face. The spring catch will be in its recess S5 holding the case and shovel immovable. The shaft R gives a twist and winding action to the spring S1, and the cam C then releases the spring catch and the shovel moves rapidly downwards and forwards, the coal following the shovel. The shovel moves round till it has completed a circle. There is now coal in front of the shovel, and on the next operation the coal is fed to the furnace, this taking place every time the shovel comes round, or intermittently. The spring catch being alternately in and out of its recess S5, and depending on the position the spring catch is set in relation to the cam C will depend the tension of coil spring S1 and the force of the shovel. For a "coker" stoker it is only necessary to take away the spring catch and lever connected therewith, and the shovel will have a continuous circular motion for the delivering of coal to the furnace. (*Accepted April* 17, 1918.)

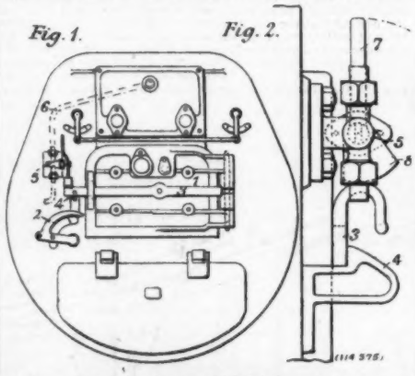
114,760. Aktiengesellschaft Brown, Boveri und Cie, Baden, Switzerland. Turbine Installations. (2 *Figs.*) May 14, 1917.—In marine turbines it is a usual expedient to arrange the forward or low-pressure forward turbine and the rearward or low-pressure rearward turbine in a common casing. In the case of quick-running land turbines, it has been proposed to split the forward portion or low-pressure forward portion, and to arrange the exhaust ends together in the middle or at both ends of the casing. According to the present invention, the two above-mentioned arrangements each of which is known *per se* are combined together with the additional novel feature that the rearward turbine is now arranged in the common exhaust space of a double-sided forward turbine having two portions operating in parallel, that is to say, in the middle of the casing. In Fig. 1, *a* is the high-pressure turbine, *b* the double-ended low-pressure





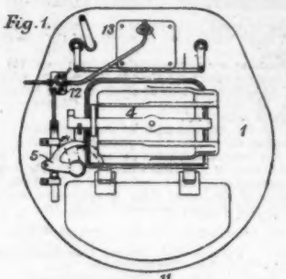
turbine with a rearward turbine, *c* the speed gear, *d* the propeller shaft with propeller *e*, *f* the steam supply pipe to the high-pressure turbine, *f* the steam supply pipe to the rearward turbine, *h* and *i* are pipes connecting the high-pressure portion and low-pressure portion, *k* is a controlling valve for forward travel, *l* is a valve for rearward travel, and *m* and *n* are stop valves in the connecting pipes *h* and *i*. The latter allow of equalising to some extent the distribution of the power to the two driving shafts, in the case of small loads and amounts of steam, by closing one of these valves and thereby reducing the cross-section of the inlet. In Fig. 2, which is a longitudinal section of a turbine according to the present invention, *o* is the rotor with the two forward turbine portions *p*, *p*; *q*, *q*, is the common exhaust space with the rearward turbine *r*, *r* (also double in this example), and *s* is the inlet chamber for the steam supply to the rearward turbine. (*Accepted April* 24, 1918.)

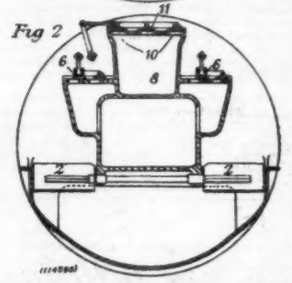
114,575. James Howden and Co., Limited, and J. H. Hume, Glasgow. Furnaces. (2 *Figs.*) September 18, 1917.—This invention relates to furnaces operating on forced draught and adapted for burning oil or coal only, or both coal and oil. According to the invention, an interfering connection is interposed between a movable latch member on the furnace door and an oil cock fitted to the oil-supply pipe. 1 denotes the furnace door hinged to the furnace front and adapted to be locked in closed position by means of a latch element 2 movable from the position in which it obstructs the opening movement of



the door. Mounted on the door 1 is a latch member 3 engageable with a stationary catch 4 and adapted to be lifted when the door is to be opened. 5 denotes an oil cock from which a connection 6 is taken to the oil burner. Fitted to the handle 7 of the oil cock 5 is a depending extension 8 which, when the cock is in open position, obstructs the latch member 3 and prevents the same from being lifted to open the furnace door, the extension 8 being so dimensioned that the path of the latch member 3 is cleared of obstruction only after the cock has been turned to closed position. (*Accepted April* 17, 1918.)

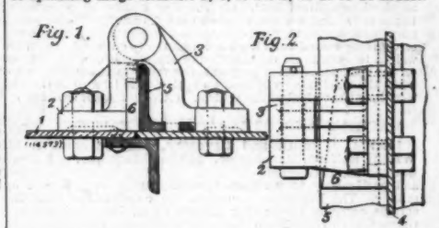
114,550. James Howden and Company, Limited, and J. H. Hume, Glasgow. Furnace Fronts. (3 *Figs.*) July 14, 1917.—This invention relates to fronts for forced-draught furnaces. A furnace front, according to the invention, is fitted with an upper manually-operated valve or valves controlling ports above the grate and at each side of the firing entrance, and adapted to be opened when coal is being burned, and, in addition, with an opening also above the grate for admission of air for use in burning oil, such opening being located directly above the furnace door, the supply of air for burning oil being controlled by a manually-operable valve independent of the valve or valves controlling the ports for admission of air for combustion of coal. The furnace front 1 is constituted by a casting formed at each side of the firing entrance with a port controlled by a butterfly valve 2, the valves 2 being mounted on a common spindle and thus operable conjointly. 4 denotes the furnace door, adjacent to which is a latch element 5 shown in full lines in Fig. 1 as clear of the door 4, but movable into the position shown in dotted lines in Fig. 1 to prevent the door from being opened. 6 denotes upper slide valves coupled together and controlling ports for admission of air to the firing entrance. Above the firing entrance





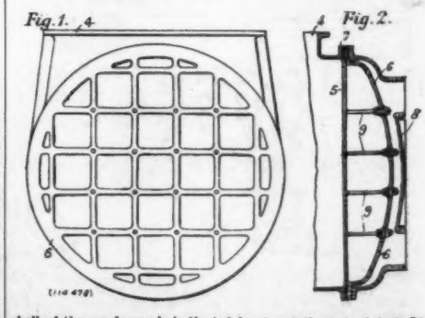
is an air-controlling and guiding chamber 8 in which is fitted an oil burner, the admission of air to said chamber 8 being by way of ports 10 controlled by a manually-operable slide valve 11. 12 denotes the cock controlling the flow of oil through the pipe 13 to the oil burner, said cock being operatively connected with the device 5 for locking the furnace door 4. (*Accepted April* 17, 1918.)

114,573. James Howden and Co., Limited, and J. H. Hume, Glasgow. Smoke-box Doors. (4 *Figs.*) September 4, 1917.—This invention relates to an improved smoke-box door. There are secured to the stile plate 1 angle brackets 2, each forming a stationary hinge element with which co-operates a movable hinge element 3 secured to the door 4. Between the co-operating hinge elements 2, 3, is fitted, so as to be slidable



in a direction parallel with the axis of the hinge, a wedge device constituted by an angle bar 5, to which are secured wedges proper 6, one end of one wedge having a projecting extremity adapted to be struck by a hammer so as to move the angle bar 5 and thereby to bring the wedge proper 6 out of bearing engagement with seating faces presented by the hinged elements 2. (*Accepted April* 17, 1918.)

114,478. A. E. L. Scanes, Ashton-on-Mersey. Steam Condensers. (3 *Figs.*) April 5, 1917.—This invention relates to surface condensers in which the tubeplates are braced or stayed to prevent distortion. According to this invention, instead of attaching tension stays to the end covers, there is provided within the main cover a separate skeleton cover or grid to which the tension stays are secured. This skeleton cover or grid may be fastened to the condenser body by means of collar bolts, and will not be disturbed by the removal of the end covers. The



shell of the condenser is indicated by 4 and the tubeplate by 5. The skeleton cover or grid 6 extends over the whole area of the tubeplate, the latter, as well as the grid 6, being attached to the usual flange 7 on the end of the condenser shell. The end cover 8 for the condenser is also bolted to the flange 7 so as to be capable of removal without disturbing the cover or grid 6. The tension stays 9, attached to the tube-plate 5, pass through the grid 6, to which they are secured, and thus hold the tubeplate against distortion. (*Accepted April* 17, 1918.)